MACHINERY.

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THE GAS ENGINE.

GEORGE RICHMOND.

THE term "hot air engine" is by common consent restricted to a certain class of machines, which to-day possess little more than an historical and academic interest. This is rather unfortunate, since we need the term to describe a whole class of engines which have succeeded the hot air engine and to a great extent realized the expectations so sadly disappointed by it.

For the gas engine, gasoline engine and oil engine are all species of hot air engines. In each case heat is the motive power and the transformation of heat into work is effected by the heating and cooling of air, as an agent.

The only essential difference between a steam engine and a gas engine is in the agent used, vapor in one case and air in the other. The general theory is the same for each, and contrary to current belief the subject is one of extreme simplicity. Putting aside the prejudice inspired by preconceived ideas and a little perhaps by the phraseology employed, it will be found that the problems of thermodynamics required for an elementary, but adequate, study of heat engines are as easy of solution as measuring up a piece of work with a foot rule.

We cannot afford to ignore these questions; if we regard the gas engine simply as an ingenious piece of mechanism we shall miss some of the most significant features of the subject.

As a heat engine the gas engine enjoys the distinction of converting into work a greater percentage of the heat supplied to it than the best steam engine does. This important fact had no particular significance in the earlier applications of gas engines. They were adopted on account of their convenience, and even to-day are regarded by many as a poor apology for a steam engine. It must be admitted, indeed, that the ordinary gas engine is lacking in the adaptability and elegance of the high grade modern steam engine. The fact, however, that the possible efficiency of the gas engine is greater than that of the steam engine is ever expected to reach, has forced the gas engine into prominent rivalry with the steam engine, and stimulated the study of its principles and means of improvement.

Geo. Richmond

An infinite variety of gas engines has been described and many constructed, but the only type practically in use at the present time is that invented by Dr. Otto. In the course of a tedious lawsuit, evidence was unearthed that the cycle of operations used by him had been previously most minutely described by Beau de Rochas.

It seems improbable that the mechanical world would ever have profited by De Rochas's ideas unless some one had re-invented them and put them into practical shape, and Dr. Otto seems to be entitled to the full credit of having done this.

It is not asserted that the "Beau de Rochas" or "Otto Cycle" is the only practical one for a gas engine or even the best. It is significant, however, that a number of ingenious arrangements claiming distinct advantage over the Otto cycle were promptly abandoned on the expiration of the Otto patents. The defects of this cycle are apparent, and probably nearly every student of the gas engine has some pet scheme for improving it. A consideration of the earlier types, marking the period of evolution, will be very instructive and hardly less so the later designs when ingenuity was stimulated by the desire of sharing the profits made by the owners of the Otto patents as much as by the hope of producing a superior engine.

Our present business is with the Otto cycle itself. Beau de Rochas described it as early as 1862 as follows:

I. *Suction* or drawing in of the change during the outward stroke.

II. *Compression* during the return stroke.

III. *Ignition* at the dead point, followed by *expansion* during the next outward stroke.

IV. *Exhaust* of burnt gas during the second return stroke.

These operations require for their completion two revolutions of the engine, and the power is applied during one-fourth only of this period, namely, the second forward stroke. During this period work has to be stored up sufficient for the useful and frictional work of the next three strokes, together with the work of compressing the mixture.

This is one of the most serious drawbacks of the gas engine. To ensure regularity great reservoirs of stored work in the form of flywheels must be provided, and to ensure durability, the gas engine should be at least four times as strong as the steam engine of the same power. If we wish to utilize the parts of a steam engine to construct say a 10 HP. gas engine, we should select the crank shaft, framing, etc., from at least a 40 HP. engine.

It is notorious that proportions and rules firmly established by the best steam engine practice are totally ignored in many gas engines, and to this fact may be attributed the want of confidence which the gas engine by no means merits *per se.*

As to regularity, it is easy to adjust the flywheels to give less than the stipulated maximum of variation provided that the cycle of operations be faithfully carried out. If, however, a misfire occurs, the work of four complete strokes has to be taken out of the flywheels, and restored again, before normal conditions are reached. Regulation under a variable lead is effected in a variety of ways, by complete cut out of power stroke or by diminished force of explosion, which last result is obtained either by weakening the explosive mixture or by reducing the compression.

This compression in the second stroke of the cycle is apt to be regarded as lost work. We shall find, however, that the striking

superiority of the Otto Engine over its predecessors is almost entirely due to the compression prior to ignition. By its adoption the gas consumption was reduced from 60 to 25 cubic feet per HP. per hour, and the simplest way of obtaining a further economy is by increasing the compression. In our next chapter we shall consider the kinematics of the gas engine and the mechanical devices for producing the motions required by the cycle.

* * *

TWO NOTES OF INTEREST.

ANNEALING CAST IRON.

One of the most interesting and valuable contributions to the knowledge of cast iron is from the pen of Alex. E. Outerbridge, Jr , of Philadelphia, Pa., who made the astonishing discovery that, contrary to existing belief, cast iron is strengthened by being subjected to vibrations or light hammer blows, which, it is thought, anneals them by allowing or forcing a movement of the particles out of the strained position due to cooling after being cast. Annealing by heat is supposed to have the same effect.

This was discovered by breaking a lot of test bars which had been rumbled for several hours, and as they all gave a higher breaking strength than the regular run of iron, a dozen bars were cast in one heat, half of them being rumbled for several hours, the rest cleaned by brushing. The rumbled specimens all showed a higher tensile strength than the others, the difference ranging as high as 15 per cent. The effect of light hammering was found to be the same as rumbling. Mr. Outerbridge says:

"The result of about a thousand tests of bars of cast iron of all grades, from the softest foundry mixtures to the strongest car wheel metal, enables me to state with confidence that, within certain limits, cast iron is materially strengthened to resist shocks or repeated blows."

While this may apply to cast steel (steel castings) as well as cast iron, it evidently does not apply to wrought iron or other steels, as we find in the same works, Wm. Sellers & Co., Philadelphia, the practice of covering the inside of their crane hooks with a thin piece of wrought iron to protect the hook proper from the blows caused by the chain being thrown on the hook. These, though light in comparison with the weight and size of the hook, have been found to so hammer the surface as to cause surface cracks to start in the hook, and the introduction of the sheet metal diffuses the blow and protects the hook.

AERDROME OR FLYING MACHINE.

Professor Langley, of the Smithsonian Institute, recently made a very successful trial with his "aerdrome," as he calls the flying machine with which he has been experimenting for several years. The details are not given, but it is understood that it is built of steel, is 14 feet from tip to tip and is driven by a steam engine.

Prof. Bell, of telephone fame, describes the experiment as follows:

"It resembles an enormous bird, soaring in the air with extreme regularity in large curves, sweeping steadily upward in a spiral path, the spirals with a diameter of perhaps 100 yards, until it reaches a height of about 100 feet in the air At the end of a course of about half a mile. when the steam gave out, the propellers which had moved it stopped, and then, to my further surprise, the whole machine, instead of tumbling down, settled as slowly and gracefully as it is possible for any bird to do, touched the water without any damage, and was immediately picked up and ready to be tried again.

"A second trial was like the first, except that the machine went in a different direction, moving in one continuous, gentle ascent as it swung around in circles like a great, soaring bird. At one time it seemed to be in some danger, as its course carried it over a neighboring wooded promontory, but apprehension was immediately allayed, as it passed twenty five or thirty feet above the tops of the highest trees there, and, ascending still further, its steam finally gave out again, and it settled into the waters of the river, not quite a quarter of a mile from the point at which it arose.

"No one could have witnessed these experiments without being convinced that the practicability of mechanical flight had been demonstrated."

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To LEVEL SHAFTING, the work may be greatly facilitated by hanging two pieces from the shafting, long enough to reach from the floor, these pieces being cut out to receive a straight edge on which the level may be placed.

EFFICIENCY OF BOILERS AND ENGINES,—2.

EQUIVALENT EVAPORATION.

THEO. F. SCHEFFLER, JR.

Calling water evaporated per hour 6.8 pounds; coal consumed, one pound per hour; steam pressure by gauge, 68 pounds; temperature of feed-water, 176° Fahr. What is the equivalent evaporation from and at 212°? 68+15=83 pounds absolute. One pound of steam at 83 pounds absolute steam pressure contains 1209.8 thermal units of heat, or British thermal units, abbreviated B. T. U. The temperature of the feed-water is 176°; hence 1209.8−176=1033.8 units of heat required to raise each pound of steam to given pressure; but 6.8 pounds of water have been evaporated by 1 pound of coal; hence the total number of heat units given out by 1 pound of coal will be 1033.8×6.8=7029.84. To evaporate 1 pound of water from and at 212° requires 965.7 units of heat; hence dividing the units of heat given out by 1 pound of coal, as found above, by 965.7, we have

$$\frac{7029.84}{965.7} = 7.27$$

pounds of water evaporated from and at 212°.

Another way the above may be expressed is as follows: For comparing boiler tests the results obtained are often reduced to a common standard evaporation reckoned from and at 212° Fahr. If, for instance W= pounds of water evaporated in test per pound of fuel, the water being supplied at a temperature of say t° Fahr.; H=total heat of steam in British thermal units at the temperature corresponding to the pressure calculated from zero Fahr.; t=temperature of feed-water. Then, to find W^1 the equivalent evaporation from and at 212° Fahr., we have the following formula:

$$W^1 = W\frac{H-t}{965.7} = \text{equivalent evaporation.}$$

H may be found in any standard text book giving the properties of saturated steam.

STEAM.

Theoretical amount of work done by expanding from 15 pounds to 100°. If steam is admitted into a cylinder at a pressure of 15 pounds above atmospheric pressure and a temperature of 212° and were expanded to a temperature of 100°, what is the greatest amount of work which could be done according to theory, that is if there were no clearance or waste whatever? The above can be expressed by the following formula:

$$E = \frac{T-T^1}{T}$$

Where T=absolute maximum temperature of working fluid in the engine.

" T^1=absolute minimum temperature.

" E=maximum efficiency of a perfect heat engine.

The absolute temperature is found by adding 461 to temperature Fahr.

Therefore 212°+461°=673 and 100+461=561°.

Then $$\frac{673°-561°}{673} = .16 \text{ Joule's heat,}$$

which is equivalent to $\frac{1}{6}$ efficiency. Of course this formula is only true for a perfect engine, complying with conditions which are impossible in an ordinary steam engine, but the limit so determined is the highest conceivable under any conditions. The best steam engines give an efficiency little more than half that calculated above. A little further along will be given an example of a perfect engine, connected with a condenser. The above is for a perfect engine, only the first volume of steam is not expanded to such an extent, or to so low a temperature as it is with a triple expansion engine.

MECHANICAL EQUIVALENT OF HEAT.

Joule determined that when work is performed upon anything, in the end heat is produced; and that for every 772 foot-pounds performed, heat is produced sufficient to heat 1 pound of water from 32° to 33° Fahr. or 1 British thermal unit. The mechanical unit of power is the foot-pound, or the power required to raise 1 pound 1 foot high. Joule's experiments show 772 foot-pounds to be equal to one B. T. U. Later experiments, however, show the the figure to be 776. Consequently referring back to example and multiplying .16 by 776 gives 124.16 foot-pounds, which is the mechanica equivalent of heat. This is equivalent to raising 1

pound of water 124.16 feet elevation. If we divide 776 by 124.16 we obtain 6.2, which is practically equivalent to our first answer.

If we desire to know the number of thermal heat units required to evaporate a pound of water at a given steam pressure and for a given horse power from and at 212°, we would proceed in the following manner: Horse power of boiler at nominal rating equals 303; water used per horse power per hour, 34½ pounds; this latter amount is supposed to be equivalent to the Centennial standard rating, *i. e.*, 30 pounds of water per hour, evaporated at 70 pounds pressure from 100° temperature of feed-water that was selected by the judges at the Centennial Exhibition at Philadelphia, in 1876, and has received the sanction of many engineers.

We will first multiply 303 by 34½=10 453.5 total number of pounds of water required to be evaporated. To prove the above figure in another way we figure it at 30 pounds per horse power per hour; therefore, 303×30=9 090 pounds of water actually evaporated for the above total horse power. Referring to almost any text books for equivalent evaporation, we find for 70 pounds steam pressure and 100° of feed-water the constant 1.15; this constant means that 15 per cent. more should be added to the above actual evaporation; consequently we find that multiplying 9 090× .15=1363.5 pounds of water to be added to the above 9 090, therefore 9 090+1363.5=10 453.5 pounds of water, which agrees with our first answer. The 1363.5 pounds is all gain by the fact that our feed-water being 100° temperature when entering the boiler. As we require 965 heat units to evaporate 1 pound of water into steam from and at 212° Fahr., we multiply 10 453.5×965= 10 087 627.5, which is the total number of heat units required to evaporate the water to give the desired horse power.

If we should guarantee 3 pounds of coal per horse power per hour, we would multiply 303×3=909 pounds of coal consumed per hour. And to find the number of heat units that each pound of coal would have to give and be utilized by the boiler, we would divide 10 087 627.5 by 909=11 097 heat units that would be utilized by the boiler, per pound of combustible. The above 11 097 B. T. U. is equivalent to evaporating 11.4 pounds of water per pound of combustible from and at 212° Fahr. To obtain the above number of B. T. U. would require a very fine grade of coal, as well as a first-class boiler, and one with good water circulation and proper chimney area and height of stack. In order that the boiler could utilize the above number of heat units, the quality of the coal would have to be such as would give at least from 12 500 to 14 000 B. T. U. per pound, and whether the boiler would obtain the 11 097 heat units, would depend upon the boiler itself and setting. This 14 000 B. T. U. is almost equal to a pound of pure carbon; assuming that our coal was between the above figures, or the average of 12 500 and 14 000, this would give us a mean of 12 500+14 000=26 500÷2=13 250, and assuming that we have 5 per cent. of ash, we have

$$\frac{13\,250}{100-5} = 13\,947 \text{ B. T. U.}$$

per pound of combustible, then the difference between 13 947 and 11 097, which is 2 850 heat units, would be lost in the chimney flue and by bad construction. The efficiency would be 11 097÷ 13 947=79 per cent.

This is quite high, but has already been accomplished, and by referring back to the other figures, it will be observed that it is not excessively high. In connection with heat units, it will be as well to give a few examples of steam and water mixture. If one pound of steam at 212° is mixed with y pounds of water at 60° temperature, find the number pounds contained in y, when the resulting temperature is 100° Fahr.

The total number of heat units in 212° is 1146°, and as we have a resulting temperature of 100°, subtract 100° from 1146°, which gives 1046°. Then subtract 60° from 100°, which gives 40°; next step we divide 1046° by 40°, which gives us 26.15 pounds of water contained in y. In this case the y pounds of water at 60° temperature is the same as injection water for a condensing engine, and the 212° is the exhaust steam temperature (only in actual practice the exhaust steam is at a much lower temperature than 212°), and the 100° is the overflow temperature which is desired for water, and the 26.15 pounds would be the amount of injection water which is necessary to condense the exhaust steam. In other words we would require 26.15 pounds of water at a temperature of 60° to condense each pound of steam at 212°; consequently in an engine each pound or water will absorb 40° from each pound of steam.

Sometimes the overflow is fixed at about 110°, which is ordinary practice for jet condensers.

JET CONDENSERS.

In a jet condenser the temperature of the condensing or injection water is 60° and that of the exhaust steam is 212°; it is required to have the overflow water fixed at a temperature of 104° Fahr. Find the weight of condensing water per pound of steam which enters the condenser. The total number of heat units in 212° is 1146°. As we require the overflow to be 104° we deduct 104 from 1146; then 1146−104=1042°, then divide 1042° by the difference between 104 and 60, which is 44. 1042÷44=23.6° pounds of water to every pound of exhaust steam. It will be seen that each pound of water will absorb 44° from each pound of exhaust steam, and if there are 1146° in the steam, and as we desire to save the 104°, we deduct the 104° from 1146°, and then 44° is contained 23.6 times into 1042°. The overflow water from a jet or surface condenser is generally run into a hot well, from which it is pumped into a feed-water heater, or directly into the boiler; it is of course much better if it can be arranged to go through a feed-water heater, when there are a few other engines that are not running condensing; if not, it is customary to connect the feed-water heater between engine and condenser; this will be beneficial in one way, because it will partly condense the exhaust steam before reaching the condenser.

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SIZES OF CHIMNEYS.

We have received repeated requests for chimney formula, with the evident expectation of finding one which will fit every case and enable any one to tell off-hand the exact amount of power that a chimney will allow to be developed by the boilers or, perhaps, to even be so fine that by squinting at a chimney and guessing its height, one can tell how many electric cars can be run on the road or how many lamps can be lighted from the station.

But the efficiency of chimneys, like many other features in engineering, depends on the conditions at hand which must be carefully considered by the engineer before giving any decided answer. There are cases where four times the rated horse power of boilers are using a chimney with apparently good results and others where the service is below the average, the surrounding conditions being responsible for both cases.

Probably the most satisfactory formula for chimney height and power is that given by William Kent several years ago, based on the assumption that the draft power varies as the square root of the height. Taking two chimneys, one 50 feet and the other 150 feet high, it might be supposed that the latter would have three times the draft power; but on this basis it will have but 1.73 times the power, because the square root of 150 (12.24) divided by the square root of 50 (7.07) gives 1.73 as the ratio, showing that extremely high chimneys are not so much more effective than lower ones as might be supposed.

The effective area of the chimney is also to be considered, as the actual area is not all effective owing to the friction of gases. Kent gives a simple formula for finding the effective area, or E, as follows: $E = A - 0.6\sqrt{A}$ in which A equals actual area. Taking an example where the actual area is 400 square inches we have:

$E = 400 - 0.6\sqrt{400} = 400 - 0.6 \times 20 = 400 - 12.0 = 388$ square inches effective area.

The power varies directly as the effective area; that is, a chimney having 400 square inches effective area is twice as powerful as one having 200 square inches effective area.

This detail is introduced to thoroughly explain the difference between "varies directly" and "varies as the square root." Those who understand this and skip it, will be cheerfully forgiven.

Kent cites the case of a chimney 80 feet high, 42 inches in diameter which has been found sufficient to cause the combustion of 120 pounds of coal per hour per square foot of area of chimney; and taking the grate surface as 8 times the chimney area, this gives a combustion of 15 pounds of coal per square foot of grate surface per hour, which is considered fair practice for boilers with tubes of moderate diameter and enough heating surface to cool the chimney gases to 400° or 500°.

It is considered that if the chimney will give draft enough to cause the combustion of 5 pounds of fuel per rated horse power of boiler per hour, there is enough margin for cases of emergency

as a good boiler requires considerbly less coal per rated horse power.

With this assumption our chimney 80 feet high and 42 inches in diameter (9.62 square feet area), which causes the combustion of 120 pounds of coal per square foot of chimney area, gives us $120 \times 9.62 = 1154.4$ pounds per hour. Allowing the 5 pounds of coal per horse power of boiler per hour we have 1154.4 divided by 5 equals 231, showing that on this rating, this chimney is right for 231 horse power of boilers.

Calling the height H, and knowing that the power of chimney varies directly as effective area (E) and as square root of height (H), Kent makes the formula:

$HP. = C\,E\,\sqrt{H}$ where C is a constant which is determined later.

First finding the effective area (E) of our 42 inch chimney (area 9.62 square feet) we have $E = 9.62 - 0.6\sqrt{9.62} = 7.76$ square feet; the square root of $80 = 8.944$ feet. Substituting these values in the formula $HP. = C\,E\,\sqrt{H}$ we have $321 = C \times 7.76 \times 8\,944$ and transposing $C = \dfrac{231}{7.76 \times 8.944} = 3.33$ making the formula $HP. = 3.33\,E\,\sqrt{H}$ or $HP. = 3.33\,(A - .6\sqrt{A})\,\sqrt{H}$ or, to make it plainer, $HP.\ 3.33 \times (A - .6\sqrt{A}) \times \sqrt{H}$; remembering that all within the brackets are to be considered as one number, the operations usually being performed on these first.

Assuming a height of 100 feet for a chimney, and wishing to know the needed effective area (E) we transpose the formula to $E = \dfrac{0.3\ HP.}{\sqrt{H}}$, and if we have 200 HP. of boilers we have $E = \dfrac{0.3 \times 200}{\sqrt{100}} = \dfrac{60}{10} = 6$ square feet.

For round chimneys Kent advises adding 4 inches to diameter, which gives the required effective area; as this gives a close approximation and saves transposing the formula. A round chimney 33 inches in diameter gives practically the required area of 6 feet, and adding 4 inches we have 37 inches as actual diameter, or an area of 7.46 square feet. Testing this by the formula we find $E = 7.46 - .6\sqrt{7.46} = 7.46 - 1.62 = 5.82$ square feet; this is a good way to test not only your figures but the approximation, which can be varied if not deemed close enough, as in this case the addition can be made enough more than 4 inches to make up the slight deficiency.

For a square chimney the side of chimney is given as $\sqrt{E} + 4$ inches. Taking this same case and calling the chimney square we have $\sqrt{6} + 4$ inches, or 2·44 feet + 4 = inches, or 2 feet 5¼ inches + 4 inches = 2 feet 9¼ inches square, making a very easily remembered rule. It must be carefully noted that when the effective area of a chimney is given in square feet, as it usually is, the square root of this gives the side in *feet*, to which must be added the + 4 in inches. These take no account of any difference, which some claim exists, in the efficiencies of round and square chimneys, but is probably as nearly correct as anything we have yet obtained, and for which Kent is to receive full credit, the writer merely attempting to make it clear to the correspondent who inquired concerning it. C.

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ONE ON THE LINGUIST.

The other day Congressman Stone of Pennsylvania, who is one of the practical jokers of the House, approached Mr. Mahany of New York, who is an authority on Celtic orthography and orthoepy.

"Mahany," said Stone, "how would you pronounce this word,' and he spelled it out very carefully—"M-a-c-H-i-n-e-r-y?"

"That's easy," said Mahany; "that's the name of an old Irish dook—MacHinery, a little bit of Danish mixed with Milesian."

"You're mistaken," said Stone; "that's pure English—machinery."

Mahany collapsed. "Don't tell anybody,"he implored. "If that got out among the Irish of my district it would ruin me.—*Washington Post.*

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Mr. H. M. Norris, one of our well known contributors, has resigned his position as Superintendent and M. E. for Riehle Bros. Testing Machine, and editor of their *Digest of Physical Tests*, to become general manager of the Campbell & Zell Co., Baltimore, Md. This is the largest concern in Baltimore, and has about 300 men at work at present. Mr. Norris is to be congratulated on his numerous successes, and we trust his many duties will not prevent an occasional contribution to our columns.

* * *

AN ENGINEER'S EDUCATION,—1.

W. H. Wakeman.

Having heard and read of many reasons why engineers should be educated, and having no recollection of having read any reasons why they should remain ignorant, it has occurred to me that it might be interesting to know some of these reasons, as I have heard them given verbally from time to time, and to show the fallacy of some of them. It is only fair to say at the beginning of this article that I have no reference to Latin, Greek or French, that I do not bring geometry, chemistry or physics into the debate, neither do I mean the study of the higher forms of algebra or other mathematics that may be beyond the comprehension of the average working engineer, but I do include a thorough knowledge of the steam engine indicator and all of the calculations that are required to fully understand the diagrams, and what they tell us. A knowledge of steam in its various forms, how to make and use it to the best advantage, a thorough understanding of the operation of the various kinds of valves used in the various types of engines, and how to set them. Familiarity with the design and construction of steam pumps, why they are made as they are, and an understanding of the principles of the injector. The bursting and safe working pressures of steam boilers, the strains to which boilers are subjected, the bracing of flat surfaces and the collapsing pressure of tubes and flues, should all receive due attention, together with other matters that go to constitute the stock in trade of the competent steam engineer, and furthermore a large amount of good, solid common sense should be included in the above, in order that theoretical knowledge may be applied to every day practice in an intelligent manner. Having defined the term "educated engineer," as referred to here, I will proceed to mention some of the reasons given by those in charge of steam engines why they should not try to get an education.

One of the most prominent reasons is that ordinary engineers have no use for such knowledge. It is their place to start and stop the engine, see that it is properly oiled and kept clean, attend their own fires, or if they have a fireman, see that he does his work properly. The boilers must be cared for, the pumps attended to, and that is all. When a larger engine is to be purchased, or a new boiler put in, or another kind of pump set up, a consulting engineer is brought in and proceeds to tell the size of engine needed, what the new boilers should be and recommends a certain kind of pump. The engineer is not consulted in the matter at all, so that if he had studied the matter up thoroughly it would have been lost time, as his opinion was not asked for. Why was he not consulted? In a very large majority of cases it was because the proprietor or superintendent knew that the engineer had no ideas whatever on such subjects, or at least that what he did have were not worth considering. Whenever an engineer has held a certain position for several years a valuation is put upon him, or rather upon his services, by those who control the affairs of the firm or corporation, and the owner of a steam plant who will pay a consulting engineer $100.00 for giving him advice that he could just as well have obtained from his engineer without extra cost, is seldom found. An engineer who can recommend certain kinds of engines, boilers, etc., and give good reasons for his recommendations is much more apt to get satisfactory machinery to run, than one who has never given the matter any attention.

Another reason given is that they are not required to under-

stand anything more than what will enable them to run their plants, and why should they bother themselves with anything further? It must be conceded that any man who is not on the watch for something better than he now holds is devoid of ambition, and as a rule when men are without a healthy ambition to do better, they are of little value in their present situations. I do not mean an ambition that unfits them for commonplace duties, but a strong desire to get a better situation when the proper times comes.

The most absurd reason that I ever heard given for not understanding the indicator and its uses was that, if the proprietor wanted to know how much power it took to run a certain part of the factory, all that was necessary for the engineer to do was to tell him that it requires so much power, giving some reasonable sounding figures, and that was all that there was to it. Very little need be said in reply to such a statement as this, for any one who makes it assumes that every steam user is an ignoramus, which is not wholly true, and furthermore such an assertion is based on deceit, which is a very insecure foundation to say the least.

I find that some engineers are content to try and get along with their present stock of knowledge, because when something more is wanted of them they can get some friend to help them out. That this is frequently done, no one will deny, and it is one of the fundamental objects in forming and maintaining our engineers societies; but there are times when a man must act promptly, as there is no time to confer with others, even if they were at hand to lend immediate assistance, which is seldom the case when help is most needed, therefore he must have some confidence in himself, based on a sound knowledge of what is needed.

Occasionally I find an engineer who is very much afraid that he will do more than he is paid for doing, and while it will not do to wholly denounce such a rule, on the other hand, it will not do to commend it at all times and in all places. If an engineer is too willing to do everything that he can find to do around the factory, he will never be without a job on hand and he is positively sure to neglect some of his legitimate work in the engine and boiler rooms. On the other hand, if he shows no interest beyond that absolutely necessary to hold his position, he cannot blame the proprietor for declining to pay more than is due for the amount of work he is doing. This makes a deadlock, and until it is dissolved there can be no progress made. Does it pay the engineer to continue in such a course? I think not.

The claim is made that they are not paid for theoretical knowledge but only for doing the manual labor, and when they are better paid they will get the necessary knowledge. This is a mistaken idea, for several reasons. When a man gets an increase in salary, he usually takes it for granted that it is given him for what he has already done and not what he expects to do, consequently there is no special object in striving for more knowledge, and, furthermore, the attainment of a sound, thorough, practical knowledge of steam engineering is not accomplished in a day or a week, but is a comparatively slow process; hence men of long experience are considered more valuable than others, all else being equal.

A reason for lack of knowledge and no desire to obtain it that I have heard strongly put forward is, that the engineering profession is fast running down hill, so that good wages are no longer obtained by those who are engaged in it. The best reply that I can make to this assertion is to relate an incident that occurred several years ago, but which still well illustrates the idea that is in mind. A certain man who had held the position of assistant engineer in a large plant, where cross-compound and other engines were used, came into my engine room and stated that he had given up his position, as it was no longer of any value. He claimed that they were taking horse cart drivers and laborers of all kinds, giving them instructions for half a day, and putting them on as assistant engineers at low wages, and that no one could get good pay at the plant where he had been working, except the chief engineer and he received $1 900.00 per year. It will be noted that this man gave a rule, and immediately afterwards stated that there was an exception to it, and at once the query presented itself, "Why not qualify for a position under the exception, and let the laborers work under the rule?"

The claim has been made that there are so many good engineers now that there is no room for more. I am not willing to admit that this is true, for while there is an abundance of engineers who are not fully up to the requirements of a very high standard, still the old saying that "there is room at the top" still holds good. Compound and triple expansion engines are coming into use at a rapid rate and men are wanted to run them who are sober and competent to deal with them under every condition under which they may be placed; and as long as men can be found in charge of steam plants who steadily advocate the idea that if a simple engine has a cylinder large enough to give the required number of expansions of the steam, it is just as good in every way as a compound engine, and much better on account of its simplicity, there is surely a great chance for a higher education, and when it is claimed that the kind of expansion that the throttle valve gives us by wire-drawing the steam, is just as economical as any other kind, it is fully time for some one to begin to study up the principles which underlie these operations.

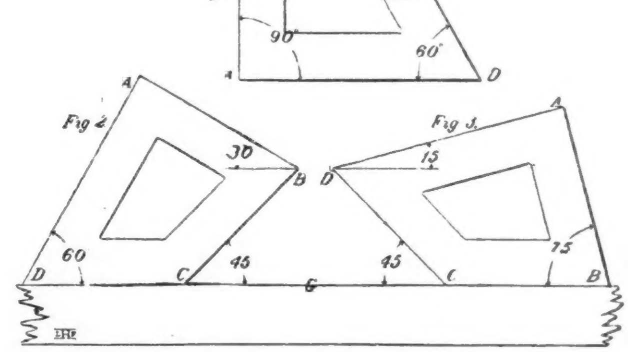
Again, it is said that it is a mistake to urge men to aspire to a higher education, for when they obtain it they will be dissatisfied with their lot in life, hence will be unhappy, because some must occupy lower places, and if all men were educated, then all would want the higher places. From an experimental standpoint no one can make reply to this objection, but owing to the fact that, as a rule, when men become fully qualified for better positions they frequently find them, and as there is apparently little danger of all being educated, it would seem to be safe to give it a trial.

* * *

THE "TET" ANGLE OR TETRANGLE.

As the appearance of the so-called "Tet" angle in the May issue has caused considerable comment, we reproduce an illustration from a circular published about seven years ago. It was called the tetrangle, as it is a tetragon or figure having four angles as distinguished from the triangle, and was patented by Prof. L. F. Rondinella, of Philadelphia, Pa., in 1889. We reprint a portion of the circular, which will explain the advantages of this instrument.

The tetrangle is a single instrument, capable of doing the work of the two triangles generally used in mechanical drawing. By its use, in connection with the T-square, any angle that is a multiple of 15° can be plotted or measured. It has, as its name implies, *four angles*, 90°, 60°, 75° and 135°, arranged as indicated in Fig. 1 above. In Figs. 2 and 3 the instrument is shown (correspondingly lettered) placed against the T-square blade in two different positions for drawing perpendicular oblique lines—30°x60°, 45°x45° and 15°x75°.



The tetrangle possesses the following advantages:

It costs only about as much as one of the two triangles of corresponding size and quality.

It makes one instrument less on the drawing-board, and prevents the loss of time and possibility of mistake caused by changing from one triangle to the other in drawing 30°, 45° and 60° lines.

It plots the angles of 15° and 75° directly instead of by the combination of two other angles as in the triangles.

It makes easy the division of the circle into twenty-four equal parts, which occurs so frequently in certain kinds of work.

The convenience of plotting the angles of 15° and 75° directly with the tetrangle make those directions feasible for use in cross-hatching. The use of these angles also open up new possibilities in geometrical design and ornamentation.

The tetrangle can be used conveniently in the three different systems of isometric drawing, in which the axial horizontals are represented respectively at 0° and 60°, at 30° and 30°, and at 15°

and 45°. The last of these systems is a very desirable one and has hitherto been accomplished only by the use of special "axonometrical" triangles.

* * *

PATTERNS FOR DECK FLANGE, COLLAR AND BONNET.

Geo. Guntz.

The illustrations show a smoke-stack passing through the roof of a boiler house, and the means employed to make the connection between the roof and the stack. The object of this article is to explain the method of laying out the patterns in sheet metal, for the several parts of the connection. Fig. 1 is a top view, and Fig. 2 a side view of the connection put together and in place, and these views are used to develop the patterns from.

It will be noticed that the collar, B, is larger than the stack, and the stack is presumed to be 30 inches in diameter outside, while the collar is 34 inches in diameter. This gives a clear space of 2 inches all around the stack for ventilation. It will also be noticed that the circle in the top view, representing the collar, is drawn in a solid line instead of a dotted line, as it should have been to make a correct drawing. The object of this will be apparent as we proceed in the explanation.

In laying out patterns in sheet metal it is as necessary to have drawings, either full size or correct scale, as it is to lay out pat-

FIG. 1

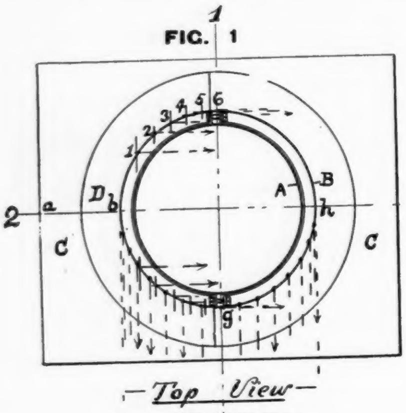


FIG. 3

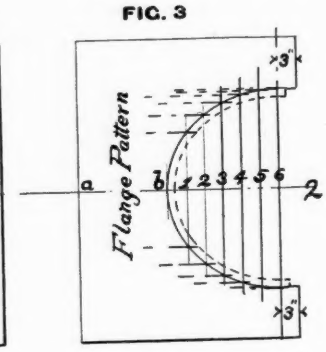


FIG. 6

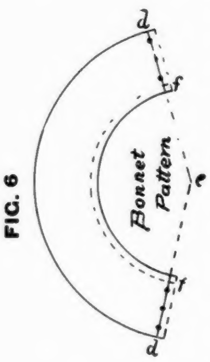


FIG. 2

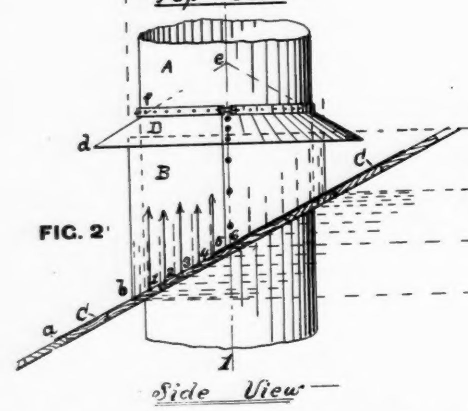
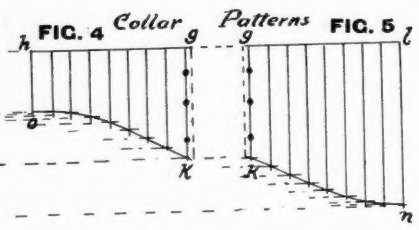


FIG. 4 FIG. 5



terns for an engine bed, a sugar mill, or a milling machine. While an expert can do very well with a scale drawing, those who only do an occasional job will find full size drawings more convenient. It will be further noticed that this connection is made in two parts, so that it can be put in place after the stack is in place, the joints being made at the sides.

In the illustrations, similar letters and figures refer to similar parts, points and lines; 1 is the vertical center line, and all joints are made on this line. In Figs. 1 and 2, A is the stack, B the collar, C the flange on the roof, and D the bonnet. Fig. 3 is the pattern for the flange; Fig. 4 is half the pattern for the upper section of the collar; Fig. 5 is half the pattern for the lower section of the collar; and Fig. 6 is the pattern of the bonnet. Now, in developing the patterns we will commence with the bonnet, D. The first operation is to extend the line *d*, *f*, the slant side of the bonnet, to *e*, where it intersects the center line 1. This, you see, makes a cone of which the bonnet is the frustrum.

Then with one point of the compass or trammel set on *e*, and the other on *d*, you have the length of the slant side of the cone; and using this as a radius, from any convenient point on the sheet of iron, strike a circle, *d*, Fig. 6, which will be a little larger than enough to go around half of the outside of the bonnet.

Set one point of the trammel on *e*, Fig. 2, and shift the other to *f*, and from the same center, *e*, Fig. 6, strike the circle *f*, as shown in dotted line. With the trammel point still on *e*, shift the other about an inch and a quarter towards *e*, and strike the inner circle; and from the point *e* draw a line, *e*, *d* say, within about an inch and a half of the end of the outer circle.

Then take a strip of light iron and measure half way around the outer edge of the bonnet, in Fig. 1, commencing at the line 1 and ending on the other side, on the same line.

Lay this length off on the outer circle, Fig. 6, commencing on the line *e*, *d*. Make a mark, and from *e* to this mark draw a line. This will give you exactly half of the bonnet. Add about an inch on the outside of these lines for laps and the pattern is complete. Punch the bolt holes and lay out the other half by the pattern, cut out and form up.

After forming turn out the flange on the dotted line 1¼ inches wide. This flange is to be used to rivet a 1½ inch by 1¼ inch band to the bonnet, so that it can be clamped to the stack, as shown, while the joints in the bonnet can either be riveted or bolted together. To develop the pattern for the flange C, take the distance from *a* to *b*, Fig. 2, and set off on the center line 2, 2, Fig. 3, and with the compass space off the half of the diameter of the collar up the slant of the roof, Fig. 2 (in any kind of spaces, but equal spaces are preferable), as *b* 1, 2, 3, 4, 5, 6, Fig. 1, and transfer these spaces to line 2, Fig. 3, commencing at *b* and ending at 6, and through these points draw lines at right angles to 2, 2, a little longer than the diameter of the collar B.

Then project the points *b* 1, 2, 3, 4, 5, 6 upward, as indicated by the arrow points, from Fig. 2, on to the circle B, Fig. 1. From these intersections project them outward as indicated by the arrow points and cutting their respective lines on Fig. 3. Then through these intersections draw the curved line *g*, and inside, about 1¼ inches, draw the flange or lap line. This 1¼ inches is to be turned up and the collar riveted to it. On the outside of 6, allow about 3 inches for laps and the pattern is complete. As both upper and lower halves of the flange are alike, but one pattern is necessary.

To describe the patterns for the collar, divide the upper quarter of the circle B, Fig. 1, from *h* to *g*, also the lower quarter from *g* to *b* into any number of equal spaces. Draw a line as *h*, *g*, Fig. 4, and *g*, *b*, Fig. 5, as an extension of the line. Indicating the top of the collar in Fig. 2 on this line, lay off an equal number of the same spaces as are contained in one-quarter of the circle B, Fig. 2, or preferably, make two sets of these spaces, as shown in Figs. 4 and 5. Having done this, draw lines from these points at right angles to the lines *h*, *g*, and *g*, *b*, sufficiently long so that they will extend below the lower point of the collar B, Fig. 2. Then drop the points on B, Fig. 1, from *b* to *g* and *g* to *h* down, as indicated by the arrow points, on to the line of the roof plane, Fig. 2; and from these transfer them in a horizontal direction on to their corresponding lines in Figs. 4 and 5, making intersections, and through these intersections draw the curved lines shown, free hand.

Then by adding the laps outside of *g* and *k*, as indicated by the dotted lines, you have half of the pattern of the lower side of the collar, also half of the pattern of the upper side, and it is only necessary to lay these patterns on the material.

Mark them out and turn them over, using *b*, *k* and *h*, *o* as the axis of revolution, and mark out the other half, thereby making the whole pattern. It is preferable to make this connection of 18 or 20 gauge galvanized sheet iron or steel, as this will permit of flanging cold to the depth of 1¼ inches easily, which flange is sufficiently large enough to take three pound rivets, and the joint between the flange and collar can be soldered and made perfectly water tight.

THE FIRST PRINCIPLES OF MECHANICS.—8.

LESTER G. FRENCH.

FALLING BODIES.

Under the influence of gravity alone, all bodies fall to the earth with the same velocity. The fact that heavy bodies actually fall more rapidly than those of less weight or density, as would be observed in the dropping of a stone and a leaf, is due solely to the greater retarding effect of the air upon the .atter. Weight does not affect the time of fall. Weight is the measure of the attractive force of gravity, and if one body weighs twice as much as another, the attraction of gravity upon it is two times as great as upon the lighter body; but as this force must accelerate twice as great a mass in the former body as in the latter, the velocity of each must be alike. An apparatus used to prove this consists of a long glass tube with closed ends, arranged so that the air can be exhausted. When this has been done, it is found that objects of varying sizes and weights will fall from one end of the tube to the other with equal rapidity.

It was stated last month that in the vicinity of New York the acceleration due to gravity is 32.16 feet per second in a second. That is, the constant increase of velocity given by gravity during each second is 32.16 feet per second. For convenience we will call it 32 feet per second. Supposing a body to be dropped from such a height, therefore, that it falls during an interval of five seconds, its velocity at the end of each succeeding second will be as follows:

		Feet per second.
Velocity at end of 1st second	=	32
" " " " 2d "	= 32+32 =	64
" " " " 3d "	= 64+32 =	96
" " " " 4th "	= 96+32 =	128
" " " " 5th "	= 128+32 =	160

It will be seen that the results 32, 64, 96, etc., may be obtained by multiplying the number of seconds by 32, the value of gravity. Hence, for finding the velocity at the end of any second we have

$$v=g\,t. \quad (11)$$

In this and succeeding formulas for falling bodies we will let

v=velocity in feet per second.

t=time in seconds.

g=acceleration due to gravity.

h=height in feet.

During the first second of fall the velocity at the start is 0 and at the close 32 feet per second. The *mean* velocity is 16 feet per second. Hence the space traversed during this second is $16\times1=$ 16 feet. A body, therefore, falls 16 feet during the first second of motion.

In like manner, the space passed through during the second second is equal to the mean velocity during that second, multiplied by the time. The mean velocity is equal to the sum of the velocities at the beginning and end, divided by the two. Hence, by the aid of the table above, we may make out another table showing the distance passed through in each second. Since the time is one second or unity, the multiplication by this factor may be omitted.

	Feet.
During 1st second space=	16
" 2d " " $=\dfrac{32+64}{2}=$	48
" 3d " " $=\dfrac{64+96}{2}=$	80
" 4th " " $=\dfrac{96+128}{2}=$	112
" 5th " " $=\dfrac{128+160}{2}=$	144

It will be observed that $48=3\times16$, or three times the space passed through in the first second. Also, $80=5\times16$; $112=7\times16$; and $144=9\times16$. From this we conclude that the spaces traversed during each succeeding second are proportional to the odd numbers 1, 3, 5, 7, 9, 11, etc., which is a useful fact to remember.

We have seen that a body falls 16 feet the first second, 48 feet the second, 80 feet the third, and so on. In two seconds, therefore, it falls $16+48=64$ feet; in three seconds, $16+48+80=144$ feet, and so on. But $64=16\times4$, or 16×2^2, and $144=16\times9$, or 16×3^2, the 2 and 3 in each case beirg the number of seconds required for a body to fall 64 and 144 feet respectively. And in general the space that a body will fall in a given time is equal to 16 multiplied by the square of the number of seconds. Hence,

At the end of 2d space $=16+48=64=16\times2^2$.

At the end of 3d it equals $16+48+80=144=16\times3^2$.

Of the 4th, $16+48\times80+112=256=16\times4^2$.

Of the 5th, $16+48+80+112+144=400=16\times5^2$.

The factor 16 that has been used is one-half of 32, the acceleration due to gravity, or $\frac{1}{2}g$. Hence, to find the total space for any time, multiply the square of that time in seconds by $\frac{1}{2}g$. Therefore,

$$h=\tfrac{1}{2}g\,t^2. \quad (12)$$

Formulas 11 and 12 are the fundamental formulas for falling bodies. By combining them algebraically we may obtain as an expression for velocity,

$$v=\sqrt{2gh}. \quad (13)$$

From 11 and 13 may also be derived

$$t=\frac{v}{g}=\frac{\sqrt{2gh}}{g}=\sqrt{\frac{2h}{g}}$$

These formulas apply to retarded motion which takes place when a body is thrown into the air, as well as to the accelerated motion produced by the action of gravity upon a falling body. Thus, when a body is thrown upward it is gradually retarded by the same amount that it is accelerated upon its return, and when it reaches the earth again, it has the same velocity that it had when it left the hand.

Example 1.—Assuming no frictional resistance of the air, (*a*) what velocity will a body have after it has fallen 10 seconds? (*b*) What space will it fall through during the 10th second? (*c*) What space will it have fallen at the end of ten seconds?

(*a*) $v=g\,t=32.16\times10=321.6$ feet per second.

(*b*) At end of 9th second $v=32.16\times9=289.44$ feet per second. Hence,

$$\text{Space}=\frac{321.6+289.44}{2}=305.52\text{ feet.}$$

This also equals the odd number $19\times\frac{32.16}{2}$.

(*c*) $h=\frac{1}{2}g\,t^2=\frac{1}{2}\times32.16\times100=1608$ feet.

Example 2.—A stone drops from a tower 200 feet high. With what velocity will it strike the ground?

$$v=\sqrt{2gh}=\sqrt{2\times32.16\times200}=113.4$$

feet per second.

THE PENDULUM.

In its simplest practial form the pendulum consists of a ball of lead or other heavy material suspended by a fine cord or wire. For convenience this may be called a *simple pendulum*, and any pendulum in which the weight is not so concentrated, is a *compound pendulum*. Strictly, however, a true simple pendulum is merely an ideal conception,—it is a particle of matter suspended by a weightless cord, and capable of vibrating without friction, while any pendulum that can be actually constructed is a com pound pendulum.

The length of a pendulum is the distance from the point of suspension to a point lying below the center of gravity, called the center of oscillation. One vibration of a pendulum consists of one complete beat one way. When it swings back and forth once, two vibrations take place.

Law 1.—When the arc swung through is small, *the vibrations occur in equal times, irrespective of the distance passed through.* Moreover, the arc may vary widely in length without materially affecting the time of vibration. Thus, a pendulum of such a length that it will vibrate once in one second, when its arc of action is five degrees, would require only $\frac{1}{200}$ of a second longer to vibrate through an arc of 30 degrees.

Law 2.—The times of vibration of different pendulums are proportional to the square roots of their lengths. Thus, the times of vibrations of pendulums 1, 9 and 25 inches long would be proportional to the numbers 1, 3 and 5. It would take the second pendulum three times as long to vibrate as the first, and the third five times as long. A pendulum which vibrates once in four seconds must be four times as long as one which vibrates in two seconds, because the times of vibrations are as 2 : 1, and these must be proportional to the square roots of the lengths, or as $\sqrt{1}:\sqrt{4}$.

Law 3.—Time of vibration varies with the attraction of gravity, but is independent of the mass. This has been proved by swinging pendulums of different lengths in various localities and pedulums of the same length, but of different materials, at the same place.

CENTER OF OSCILLATION.

The center of oscillation of a pendulum is that point which vibrates in the same time that it would if disconnected from all remaining particles. From Law 2 it is clear that the upper part of a pendulum tends to vibrate faster than the lower part, and so hasten its motion, while the lower part tends to vibrate slower and thus retard the motion as a whole. Between these two limits is the center of oscillation, which has the average velocity of all the particles of the pendulum, and which is neither quickened nor retarded by them. It vibrates in the same time that it would if it were a particle swinging by a weightless cord, as in the simple pendulum.

It may make it clearer to state that the center of oscillation and center of percussion of a body are at the same point. Hold an iron bar in the hand and strike an anvil a sharp blow with the end of the bar; it will sting the hand. Strike the anvil again with that part of the bar which is near the hand, and the effect of the blow will again be felt. Now at some point between these two a blow may be delivered and no jerk or sting will be experienced. That point is the center of percussion, which, as just mentioned, is the same as the center of oscillation. In the case of a bar of uniform cross-section, and suspended at one end, the center of oscillation lies at a distance of two-thirds of the length of the rod from the point of suspension.

THE COMPOUND PENDULUM.

In order to apply the three laws to a compound pendulum, it is necessary to determine its length, which, according to the definition previously given, is the distance from its point of suspension to its center of oscillation. This done, it may be considered as a simple pendulum having the same length, *for any simple pendulum of a given length will vibrate in the same time that a compound pendulum of the same length will vibrate.*

It is important, therefore, to be able to locate the center of oscillation. This may be done by trial. The point of suspension and center of oscillation of a pendulum are mutually convertible. If, therefore, a pendulum be inverted and another point of suspension found about which it will vibrate in the same time as before, this point will be the position of the first center of oscillation, and its distance from the first point of suspension can be measured.

TIME OF VIBRATION.

The time of vibration of a pendulum is found by the formula

$$t=3.1416\sqrt{\frac{l}{g}} \qquad (14)$$

Where t=time in seconds.
" l=length in feet.
" g=accelleration due to gravity.

In the vicinity of New York, for $t=1$, $l=39.1$ inches, or the length of the seconds pendulum is 39.1 inches.

EXERCISE 7.

1. Neglecting frictional losses, how long will it take a body to fall 1000 feet?
2. If a ball be thrown vertically upward with a velocity at the start of 50 feet per second. (*a*) How high will it go? (*b*) How long will it remain in the air?
3. A body falls 12 seconds. (*a*) From what height did it fall? (*b*) What space did it pass through in the last 2½ seconds?
4. A bullet is shot upward with a velocity of 1500 feet per second. How long before its upward motion will stop?
5. In what time will a pendulum beat whose length is (*a*) 36 inches and (*b*) 25 inches?

* * *

NOTES FROM A. S. M. E. PAPERS.

EFFECT OF FIRE ON MACHINERY.

Not long ago Mr. W. F. M. Goss had occasion to examine a considerable amount of machinery, some of which was quite heavy, which had passed through fire, the fire burning until all of the woodwork had been consumed. But little water was used, and the machinery did not suffer from this cause. Damage from the machinery appeared to have arisen from three causes, namely: the falling of the machinery, the falling of the roof timbers and walls upon the machinery, and the action of the heat itself.

Machines which were on good foundation did not suffer from the first-named cause; but when there was no foundation, even heavy tools were either broken by the fall or distorted by the combined action of the heat and of strains resulting from imperfect support after the fall. The results justify the conclusion that in case of fire an indestructible foundation is an excellent life-preserver for a machine.

To heat alone is, of course, to be attributed the destruction of woodwork about the machines, and the loss of babbitt from brasses and boxes. From this cause, also, bolts which served to connect different parts of heavy frames were often found loose. Steam-joints of every kind required refitting. *Brass bushings which originally had been forced into turned holes to form bearings for shafts or pins were all loose in the castings and tight on the shaft.* Castings having very large flat surfaces, either plain or ribbed, were in several cases found to contain fire cracks, but with a few exceptions heavy castings of good design were not injured by heat alone.

MECHANICAL STOKERS.

The general summary of tests of three types of mechanical stokers, the Wilkinson, Coxe and Babcock & Wilcox, by Jay M. Whitham, is given as follows:

1. Each stoker seems well adapted to the conditions for which it was designed.
2. Each stoker gives ideal economic results when properly handled.
3. Stoker engines use from one-fifth to two-fifths of one per cent. of the steam generated.
4. Fan blasts use from three to five per cent. of the steam generated.
5. Steam blasts use from five to eleven per cent. of the steam generated.
6. A defect, common to each of the stokers named, is a too scanty air space in the grate.
7. Neither stoker will develop as much capacity as will hand firing with stationary grates, having the same draft and coal conditions. Stokers, however, are not only more constant in the powers developed than is a hand fired grate, but are more responsive to fluctuations in the power demands. The stoker is always in the condition that a hand worked fire is in just after its cleaning *i. e.*, always clean and "ready for a pull."

THE EFFECT OF RETARDERS IN FIRE TUBES.

The trials were conducted on a 100 horse power horizontal tubular boiler at the Sutherland Avenue Station of the Philadelphia Traction Company, Philadelphia. The purpose of the trials was to ascertain under what conditions, if any, retarders in the fire tubes would add to the efficiency of the boiler.

These were made of loosely fitting strips of No. 10 sheet-iron, running the whole length of the tubes, and twisted to a pitch of ten feet, or making two convolutions the length of the tube.

It was shown *that retarders enable a boiler to be run as economically on 5 square feet of heating surface to the horse power as on 21.7 square feet, or, practically, as on any number of square feet between these limits.*

THE TESTS GIVE THE FOLLOWING GENERAL RESULTS.

1. Retarders in fire tubes of a boiler interpose a resistance varying with the rate of combustion.
2. Retarders result in reducing the temperature of the waste gases, and in increasing the effectiveness of the heating surface of the tubes.
3. Retarders show an economic advantage when the boiler is pushed, varying in the tests from three to eighteen per cent.
4. Retarders should not be used when boilers are run very gently, and when the stack draught is small.
5. It is probable that retarders can be used with advantage in plants using a fan or steam blast under the fire, or a strong natural or induced chimney draught, when burning either anthracite or bituminous coals.
6. Retarders may often prove to be as economical as are economizers, and will not, in general, interpose as much resistance to the draught.
7. Retarders can be used only with fire tubular boilers.
8. The economic results obtained on the boiler tested are ideal. showing that it was clean, the coal good in quality, and the firing skilful.

With retarders the tubes are more effectively cleaned than without their use.

9. The tests prove that the marine practice of using retarders is good, and that the claim, often advanced, that they show from five to ten per cent. advantage, holds, whenever the boiler plant is pushed and the draft is strong,

THE CONDENSING STEAM ENGINE.—1.

FOR THE YOUNG OPERATIVE ENGINEER.

F. F. Hemenway.

As Mr. Charles T. Porter once put it, in the happy way in which he is likely to state things, the piston of a steam engine is between two opposing forces, and moves in obedience to the greater force. I do not give Mr. Porter's language, I quote from the memory of years, but I think the meaning is about correct, at any rate it is the way it has appealed to me, and the way I will state it for present purposes.

Let us assume that the piece *a*, Fig. 1, is entirely free to move on the slide *b*, being induced to move by the gravity effect of the

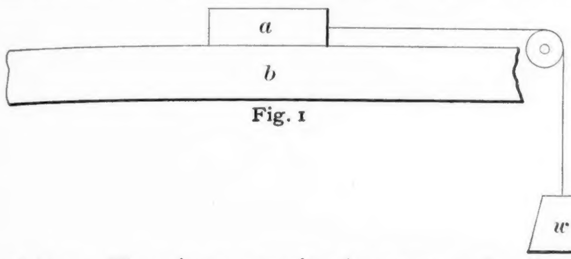


Fig. 1

weight *w*. There is no opposing force except the slight resistance of the free atmosphere.

Again assume that as in Fig. 2, the effect of weight *w* is counteracted by weight *w'*, then if $w=w'$ the piece *a* will remain stationary, and according as one of the weights preponderates, piece *a* will move in accordance with this preponderancy.

We may then very easily assume piece *a* to be the piston of a steam engine, and refer to Fig. 3. On the side *c*, of the piston *d*, is the pressure of steam admitted to urge the piston along in its path of duty, while on the side *c'* is the resisting pressure, represented by the pressure of the atmosphere, say in even figures 15 pounds. This is supposing the engine to be non-condensing. If condensing, the resisting pressure will be very much less than 15 pounds, according to the efficiency of the condensing apparatus. This resisting pressure takes away so much from the effect of the force that is urging the piston forward. It is for the purpose of removing this resisting pressure that opposes progress, that the engine is made condensing.

It is sometimes—very frequently—believed by young engineers that the condensing engine is in a sense an innovation. Such is not the case. In the earlier days of steam engineering the construction of boilers was such that only very low pressure could be safely carried; hence the importance of removing, just as far as could be done, the resisting pressure in the cylinder. In the instance of the use of high pressure steam, the gain by doing this is important, but its importance increases as the pressure is diminished, until eventually it becomes almost a necessity. This is easily comprehended.

MEANS EMPLOYED.

Different means are employed for getting rid of the resisting force in the cylinder of a steam engine, in land engines the most common being the jet condenser and air-pump, a jet of cold water meeting the exhaust steam in the condenser, all the resulting water being removed by the air-pump, thus of course, if things go right, maintaining a vacuum more or less perfect. The whole

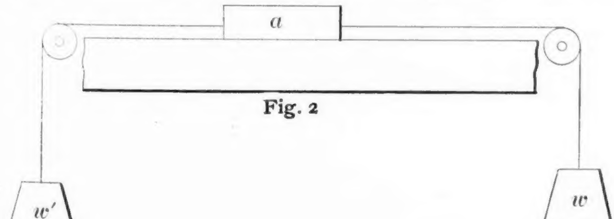


Fig. 2

apparatus is extremely simple, one principal consideration being that of keeping every working part tight. This in reference to *all* valves and to the piston. The engineer must take the apparatus as he finds it, and can do scarcely more than observe this. There must be no air-leaks anywhere about the condensing apparatus, nor into the cylinder of the engine, otherwise the results will be unsatisfactory; and this it may be stated right here is the case, whatever the condensing apparatus may be.

I was once called upon to do the best I could to secure the acceptance of a compound engine that had been guaranteed for a high duty under the circumstances. For a time it looked as if the engine would win with just about nothing to spare, when the vacuum went down about four inches. That would surely beat the engine, which had still twenty hours to run. Things looked blue. A little more injection was given, but with no beneficial results. In sheer desperation, as it were, a liberal dose of cylinder oil was given the piston rod, and almost instantly the four inches vacuum were regained. Cylinder oil was not spared on that rod, and the engine came in a winner. I was younger then than I am now, and felt rather proud over the matter. I am

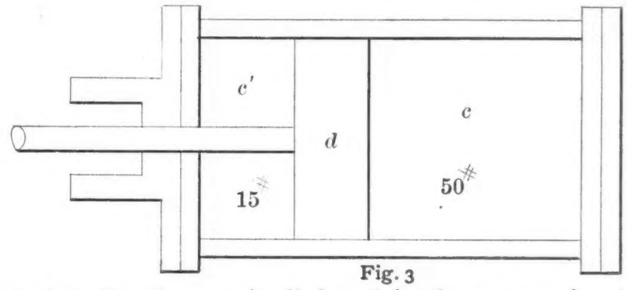


Fig. 3

not advocating the use of cylinder oil for the purpose of maintaining a respectable vacuum, but this was a case of emergency and emergent action must be taken.

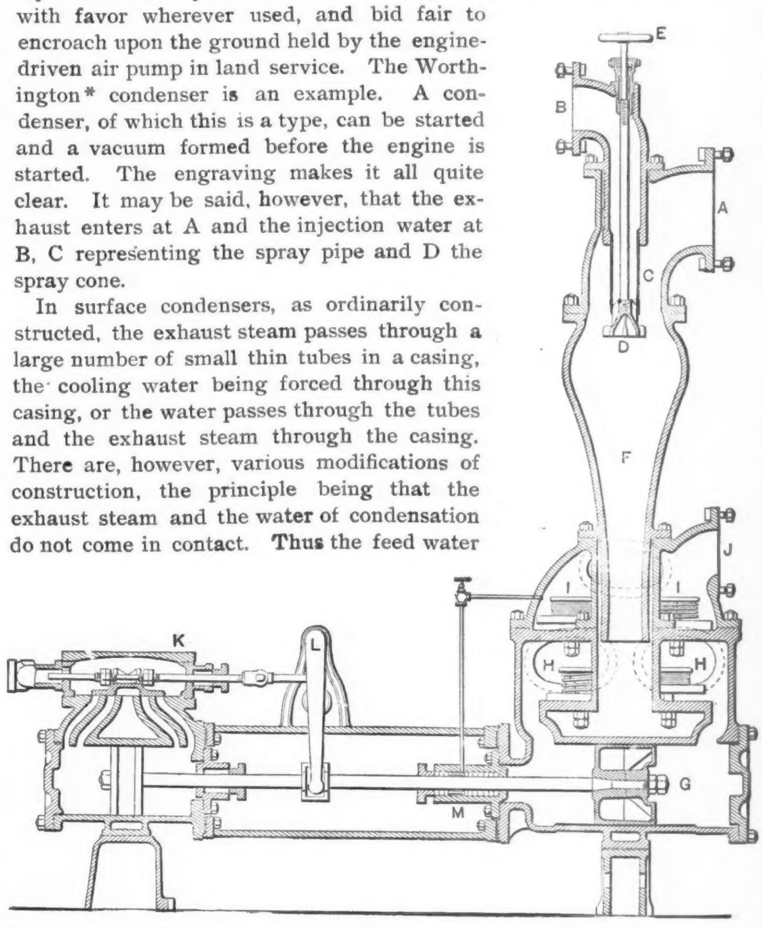
VACUUM OBTAINABLE.

It is of course desirable to obtain as good a vacuum as possible without too great cost. After going beyond 27 inches the condensing water required increases so rapidly that it generally costs more to handle the water than the gain amounts to; 26 inches is by far more common. Of course much depends upon the temperature of the water used for condensation, and upon the construction of the condensing plant. All these things the engineer must determine for himself for every particular case. The great point—the objective point—in this is to use as little water as possible and maintain a good vacuum. It costs coal to handle the water, which is plain enough.

INDEPENDENT JET CONDENSERS.

Of late, independent jet condensers have come very considerably into use; they seem from their very independence to meet with favor wherever used, and bid fair to encroach upon the ground held by the engine-driven air pump in land service. The Worthington* condenser is an example. A condenser, of which this is a type, can be started and a vacuum formed before the engine is started. The engraving makes it all quite clear. It may be said, however, that the exhaust enters at A and the injection water at B, C representing the spray pipe and D the spray cone.

In surface condensers, as ordinarily constructed, the exhaust steam passes through a large number of small thin tubes in a casing, the cooling water being forced through this casing, or the water passes through the tubes and the exhaust steam through the casing. There are, however, various modifications of construction, the principle being that the exhaust steam and the water of condensation do not come in contact. Thus the feed water



can be used over and over, furnishing the boiler with clean water, while dirty water can be used for cooling.

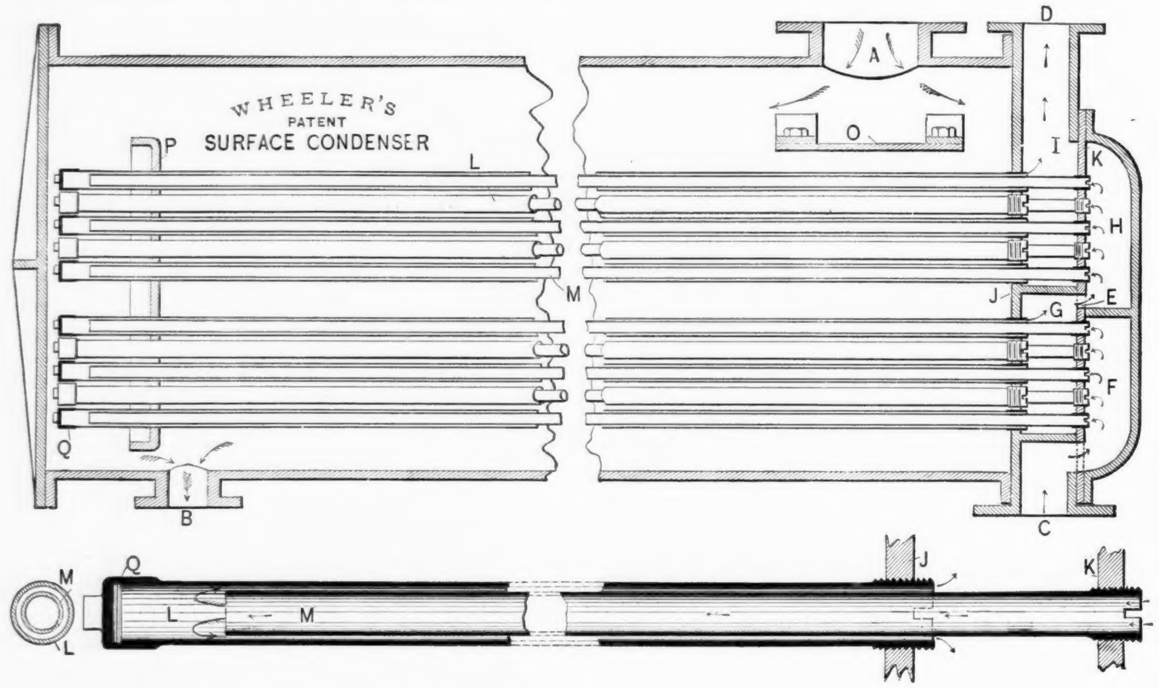
The engineer in operating this condenser sets the pump in

* Henry R. Worthington, Brooklyn, N. Y.

motion; this forms a vacuum all the way back to the cylinder including in injection pipe, and brings water into the condensing cone F. The main engine is then started and the condensation goes right along.

There should be but little difficulty to the engineer in getting along with one of these condensers. Should it become clogged, of which there seems but little danger, owing to the amplitude of the opening around the spray cone, it can be readily cleaned by momentarily lowering the spray cone by means of the hand-wheel E.

In the †Wheeler surface condenser the construction is different from that previously referred to. In this condenser there is a tube within a tube, so as to allow for contraction and expansion without danger of the tubes buckling, by which they are frequently destroyed in the ordinary condenser. In this condenser, as will be noted, neither the inner nor the outer tube is made fast at but one end only. An examination of the engraving will be interesting and instructive. No description of the condenser is intended, but for the benefit of the young engineer who is reading up on the subject of condensation it may be said that the exhaust steam enters at A and strikes the baffle plate O. This avoids the danger of cutting the tubes directly under the opening, and better distributes the steam. B is the passage-way for the condensed steam to the air-pump, C the passage for the condensing water, and D the outlet for the same.



If from any cause the vacuum becomes broken, the exhaust steam escapes by blowing through the injection pipe and through the valves of the pump, carrying the water before it. This prevents flooding.

TO PREPARE, TEMPORARILY, FOR TROUBLE.

In either type of condenser there is always the liability to slight derangement. Valves may fail in either type, and it is the part of wisdom to be prepared to meet such an emergency with such small parts as can be kept in hand just about as well as not. For example, valves are sure to wear out and will be needed some time, anyhow, and one or two might as well be ready for quick service, and so with other small parts. It is the duty of the engineer, so far as possible, or so far as he is allowed, to be prepared to keep the wheels turning. The condenser adds something to his responsibilities.

If an ordinary surface condenser is used, a tube is likely to fail at any time; if some hard pine plugs are at hand it is an easy matter to plug the ends and keep right along without serious delay, and so with other details that will suggest themselves to the competent engineer. The idea is to keep the condensing apparatus in condition the same as any other part of the engine.

BREAKDOWNS,

Break-downs may occur in the instance of either kind of concondenser named, that cannot be temporarily dealt with. The condenser must be thrown out of use, and work must proceed without it. There are means provided for doing this, and the engineer should have carefully considered what he will do should this occur. Will his engine drive all the machinery by running non-condensing, or must some of it be thrown off? Which is it likely to be of the most importance to keep moving, and how is the other to be cast off till repairs can be made? If a breakdown of a non-condensing engine occurs it means a stand-still all around, but if the condensing apparatus of a condensing engine breaks down there is still the chance of running non-condensing, driving at least part of the machinery. The engineer should have matters so well in mind as to be able to state without much delay what part of the total work his engine can do under the changed conditions. This may, under certain circumstances, be of decided importance.

Several other forms of condensing apparatus will be shown in the July number.

* * *

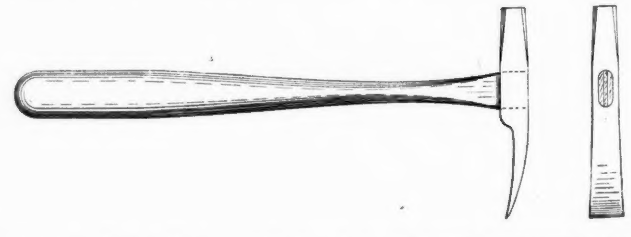
† Wheeler Condenser and Engineering Co., New York.

A DRAFTSMAN'S HAMMER.

GEO. A. FAIRBANKS.

I think that I can offer an improvement in the form of hammer to be used with the small tacks, as described by Mr. G. Edward Smith, in the March number. The style of hammer shown in the accompanying illustration, and used quite extensively in this section, is adapted to withdrawing the tacks as well as driving them.

It is, of course, magnetized. One point that Mr. Smith forgot to mention in favor of the small tacks is, that only costing three cents a package, they may be used much more generously than would be practical with the more expensive thumb-tacks, thereby obtaining a more satisfactory "stretch" on the board.



The combination triangles described in the same article, I did not like. I have yet to see a triangle, metal excepted, that will not get out of shape once (and sometimes twice) in a while, and require truing. That, I am afraid, would be a difficult matter with an interior angle. On the other hand, I wish to thank Mr. Smith for suggesting the holder for the sand rubber. It is new to me. I have been in the habit of cutting my sand rubber into strips, but have used it with thin celluloid instead of copper, finding it so easily cut and shaped, with a pocket knife, to fit any corner.

SOMETHING ABOUT DRILL JIGS.

E. Lawrenz.

To say anything new about drill jigs would be a difficult matter; however, an attempt will be made to point out such characteristics as are essential with a good tool of this kind. A good deal of what follows will also hold for other tools, since the difference between a drill jig and other machines is relatively slight, the former being useful by virtue of their rigidity, while the latter have some part or parts movable, by which work is performed. The principal and most important object of any jig is to produce any number of given parts exactly alike, or practically so, at the least cost. A jig is always a more or less an expensive affair, and the work demanded from it will dictate the degree of perfection which must be imparted to it while under way of construction. For a simple piece, never intended exactly to replace some other one of the same kind, a comparatively cheap device may be provided, while for machine parts of intricate nature and where absolute interchangeability is the object sought, the jig must be perfect without doubt.

Further, jigs may be said to go in pairs—one for support, the other for the attachment, and such a pair must be even more perfect with respect to each other. The best scheme in this case is to have them made by the same methods, tools, and, if possible, the same man in the shop, for if a deviation from measures given occurs in any one of them, incident to imperfection of tools and other means employed, they also very likely will occur to the complementary jig in the same sense. This consideration has less to do with the planning and devising of jigs, and is more in the line of the executing foreman, or other officer, but should not be lost sight of on the part of the designer either. It is not always an easy matter to design a drill jig correctly; however, there evidently are certain laws, so to speak, which, when observed, will greatly add to success. Among them is one that, if jigs are made, they should be so constructed as to start the holes on any two pieces which are to be fastened together, on the faces of their contact. This consideration is, apparently, of but minute significance, yet is important enough to influence the quality of work produced, so much so that upon this observance the total usefulness of the jigs may depend. As a matter of fact, we all know that drills will "run," no matter how rigidly they may be guided, and if we start these holes from those sides contrary to the caution above and a running-out of drills take place, we may easily imagine the consequences. To make the contact-faces of work the thrust-bearing elements, and therefore start holes from opposite sides, in many cases simplifies matters greatly for the designer, but the results from the jigs are affected. Sometimes it is necessary to hold work in jigs that have but few spots finished, while those sides coming nearest, although not touching each other, are rough, when just these faces are the ones to resort to for alignment. For to go to work and mill these sides, or otherwise touch them up before jig-drilling them, may become a costly expedient, especially so when thousands of parts have to be made, and it cannot be considered, since every motion or operation of the working man, machine, or both, adds to the expense of manufacture, which may mean money wasted. Looking at the matter in this light it becomes a question whether or not it is more advisable to divide up the mode of operations so as to perform a part of the machinery first, next drill all or some of the holes, and finally accomplish the remaining milling, planing, etc., and in fact in many cases the drilling must be done before anything else.

An important matter about drill jigs is lightness. To obtain this, just as little metal must be used as is necessary to sustain the strains brought to bear upon them. If too much metal is used the extra expense incurred upon the foundry bill is of no significance, while those of extra wages paid for handling such jigs are very perceptible at the end of the year. All metal should be so placed as to be in line with the strains exerted upon, and thus jigs should be cage-like, as it were, and not solid boxes; the advantages obtained are manifold. While they are light they also are easily cleaned and give perfect control of the operator over his work. Another question of importance is the clamping of the work. By this the particular device is not meant, for if one prefers screws somebody else chooses cams, wedges, etc., but the point of application should be taken care of and should be below the holes to be drilled. The shifting tendency of a bent drill, if its use is tolerated at all, is not sufficiently great to loosen the work in the jig, so that if all things be at their best, there is no necessity to hold the work so firmly sideways as to press the jig out of shape. At times it seems impossible to support the work this way, because the drill will destroy the supports, but then they may be made cup-shaped so as to receive the drill and some chips in coming through. For some purposes it is even advisable to make the bushings adjustable, and, by properly designing them, capable of clamping; this is nothing new, but has fully demonstrated its practicability and economy. It also will always pay to make a drawing for the jig and not, as some are apt to practice (because they want to save the few cents otherwise paid to the fellow with the pencil) go to work and nail a frame together, sandpaper, apply plenty of putty, or beeswax, paint it black and then call it a jig-pattern. It invariably will result in a poor substitute of the requisite tool, never be (if there are any number of jigs) in harmony with any of them, and, finally, is very expensive in the long run. Then, also, a drawing so made always represents a record which can be looked upon as correct, which contains all the ideas and the theory upon which the tool was built, while otherwise if drawings are made for record's sake from existing things, they never will express the full meaning and ideas of what they represent, and are therefore useless or worse.

* * *

BORING CYLINDERS WITHOUT STOPPING.

Mr. Editor:

It used to be considered rank heresy in shop practice ever to start a boring cut without finishing it without a stop, no matter if the engine and the whole shop shafting had to run half the night just to bore an 18×24 inch cylinder.

It isn't much of a trick to bore a cylinder in good shape if you have good tools and know how to use them; but when you have one of the many patented boring bars which have become loose in the joints and are too light for the work in the first place, it's something of a knack to get things in shape so one defect offsets the other, so to speak, and Dick Donald was the man who had been selected for this kind of a job and had got the thing down pretty fine.

It was kind of funny how the last cut in a cylinder always happened to be started about half an hour before quitting time, so the tool would be two or three inches in the cylinder when the whistle blew, and then the man on the boring bar knew he was in for several hours of night work. No one likes to work in the night, and it would seem as though work might be planned so as to start a cut in the morning; but when we stop to think that night work was always paid "time and half time," and Dick Donald as well as a good many others "worked" the "don't-stop-the-cut-in-the-cylinder" fad to the queen's taste—whatever that is.

Now don't blame Dick, for he wasn't responsible for the fad; the foreman, and about every one else, too, used to howl about the "ridge" the tool left when it stopped, and some even went so far as to pull the bar around by hand to prevent this. It will also be found in some books to-day, but is dying the death of a good many other shop maxims. The foreman also knew the planning that was done to get the last cut started just before quitting time; but what can one foreman do against a lot of men just as sharp as he is, and only giving regular pay wasn't even thought of.

One night Dick, more by force of habit than anything else, got his finishing cut started about quarter past five, and by six the tool was well in the cylinder, so it could not be stopped without leaving that imaginary ridge. The foreman came along a little before six and said: "Well, Dick, I see you're at the same old trick—time and half time, again I suppose?" which wasn't either denied or affirmed, as everyone knew it. But just after the foreman left, Dick happened to think of a dance that he was booked for that night and was to take the best girl in town—for him—for she was to be Mrs. Dick before long, if nothing happened to make her kick over the traces.

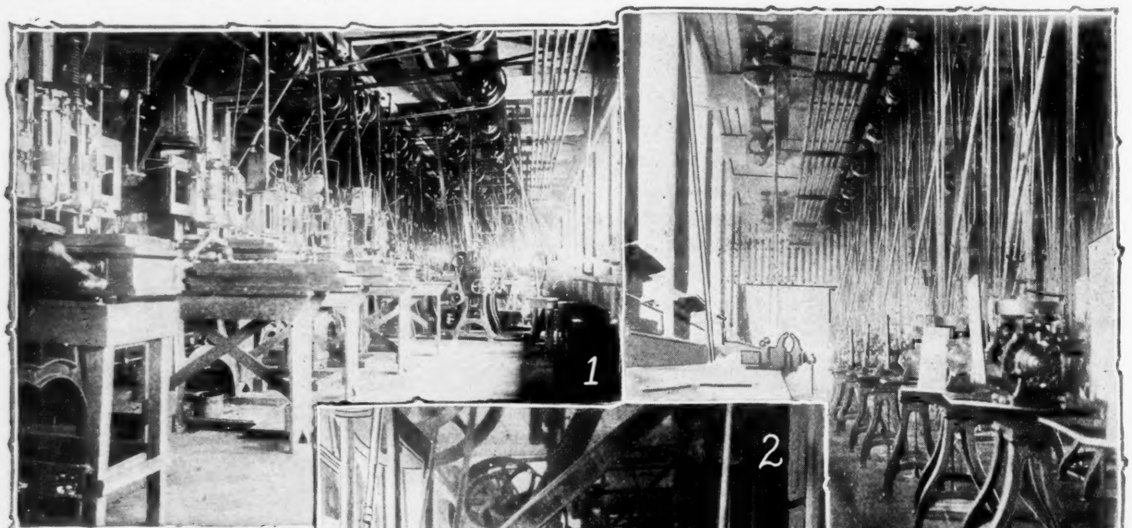
Here was a mess surely, but Dick knew that the dance *must* be attended to even if the cylinder had two ridges. Dick didn't more than half believe in the ridge theory himself, but had never experimented any, being induced not to by the overtime and extra pay; but here was a chance to try it and take in the dance too. That cut stopped at six o'clock and Dick danced still further into the good graces of the future Mrs. Dick.

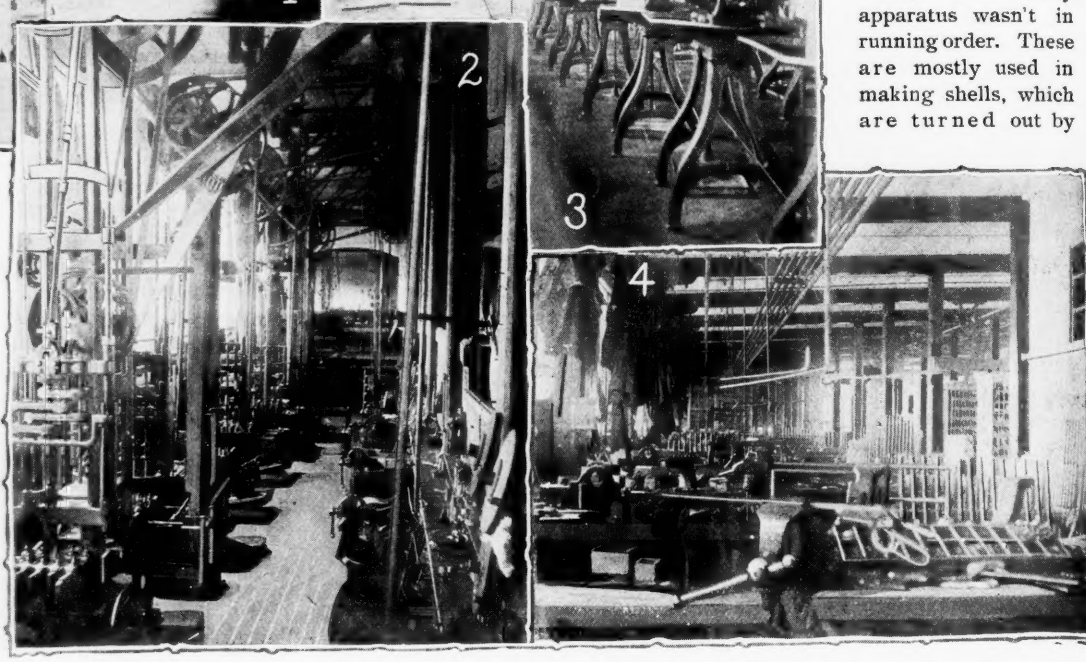
Next morning he started the cut again and was a little shaky in his shoes, if the truth must be told, for though he didn't be-

lieve the ridge theory, there was a certain shakiness about trying it the first time. Pretty soon the foreman came along and was almost aghast when he found the cut had been stopped and wanted to know why he hadn't sent for some other man to keep it going. Then Dick told the foreman that he believed the ridge theory was all bosh anyhow, and even if it did knock him out of a little overtime occasionally he wasn't going to run that bar through—especially when the future Mrs. Dick had been invited to a dance.

The foreman had misgivings by the dozen and wanted to *feel* in the cylinder, but as that would have required stopping again he desisted, but hung around when the cut was about finished. When they took out the bar you could *see* where the tool stopped, of course, always can, but the ridge was missing, or so small that 'twould take a good deal finer instrument than railroad shops ever have to find it. And even if there was, how long would it last with a piston going over it several times a second? There has been money enough spent in paying men overtime boring cylinders without stopping to pay for a good many engines, to say nothing of the cost of running the engine, the shafting and a lot of other things before getting the power to the bar as you want it. But imagination and old shop maxims go a good ways and are hard to contest.

R. E. Marks.





IN A GUN FACTORY.

GROUP I.

1.—"EDGERS," OR VERTICAL MILLS.
2.—POLISHING BARRELS.
3.—SCREW MACHINES.
4.—ASSEMBLING ROOM.

IN A GUN FACTORY.

If it is true, as is often claimed, that the implements of war are in reality angels of peace, then the Winchester Repeating Arms Co., of New Haven, Conn., are among the benefactors of the world, and should receive the thanks of the various peace societies with long names. This company is probably as well equipped for the manufacture of arms and ammunition as any concern in the country, with its fifteen acres of floor space and 1,900 employees, the fair sex being well represented among this number. That they have not reached the limit is evidenced by the large buildings which were in process of erection during my visit some time ago. As in most gun and sewing machine work, and bicycle work might also be included, the milling machine is an ever-present factor; the vertical machines with numerous spindles, called "edgers," and machines of the Lincoln type being in the vast majority. The Lincoln machine has its defects, of course, but when we see the work it can do and consider the date of its design, we cannot help feeling that its designer "builded better than he knew," as the saying goes.

The first figure of group one shows a lot of edgers and gives an idea of their general design. In Fig. 2 the machines used for polishing gun barrels are shown, this department being in the basement, but the machines extend to the second story. There is sort of a crosshead which is actuated by the connecting rod shown in nearly a vertical position in the foreground, and this carries the barrels to be polished. These are held in revolving chucks, driven by a splined shaft which transmits its rotary motion to two other spindles by the short horizontal belts shown; the other three being driven from the gear above the first belt, gearing to the second shaft and this belting to the others and so on as before. This gives the barrels a rotary motion at the same time they are being moved vertically through the polishing material, and does good work in a short space of time. Fig. 3 is a view in the small screw department, the automatic screw machine not being materially different from the regular design. In Fig. 4 is shown a portion of one of the assembling rooms, where repeating shot guns were being put together in short order by experienced men.

Drop presses are numerous, how many the writer cannot say, his education being limited when it comes to counting; and as many of these are special machines, not for the gaze of the eyes of the multitude, the camera was obliged to forego its usefulness while in this department, and the X ray apparatus wasn't in running order. These are mostly used in making shells, which are turned out by thousands; this department being mostly populated by girls—of various ages. The presses run from 100 to 200 strokes per minute on the smaller shells, and the way they are handled is a revelation to the novice. As brass becomes tempered and brittle by drawing and working, it is necessary to anneal them between the operations. This is done very neatly by passing them on a revolving plate before a Brunsen burner, and by the time they reach the next press they are annealed and again cool enough for handling. After the last drawing they are annealed in a revolving furnace and finally polished by rattling in a solution of soda. The rattlers are shown in Fig. 6, and consist of stout tubs, which are placed on spindles at the angle shown, and revolved at the desired speed. Each tub is driven independently and is controlled by the handle shown at the left.

The accompanying figure (5) shows a regular stock turning lathe, the rough block in front and the iron "form" behind it. This is really a forming lathe in which the cutting tool is practically a circular saw, and which is guided to its work by the iron form behind. It was impossible to secure a satisfactory photograph of

this, but the one shown will give an idea of the construction of the lathe.

The next group gives three views of different machinery used, the left-hand picture, No. 7, giving an idea of the extent to which Lincoln millers are used in this class of work.

The shells made by this company are not confined to small sizes, some of them being 6 inches in diameter by 40 inches long.

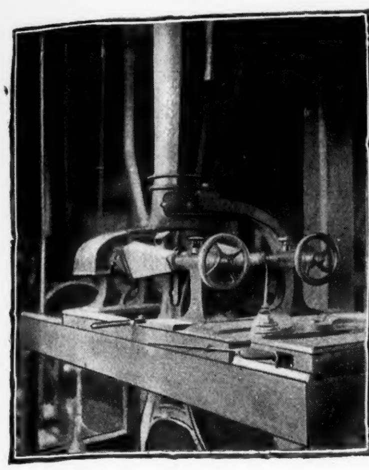


FIG. 5.—STOCK TURNING.

FIG. 6.—RATTLERS FOR CLEANING SHELLS.

This work is done in two operations, the preliminary drawing being done in a smaller press, while the finishing touches are put on by the vertical hydraulic press in the center of group, Fig. 8. The blank is sort of a cup-shaped affair, about ⅞ of an inch thick. The final pressure to which it is subjected is about 8,000 pounds per square inch. A good idea of the height and massiveness of the press can be obtained by noting the chairs at the right.

The last picture of the group, Fig. 9, shows the lathes that thread the breech

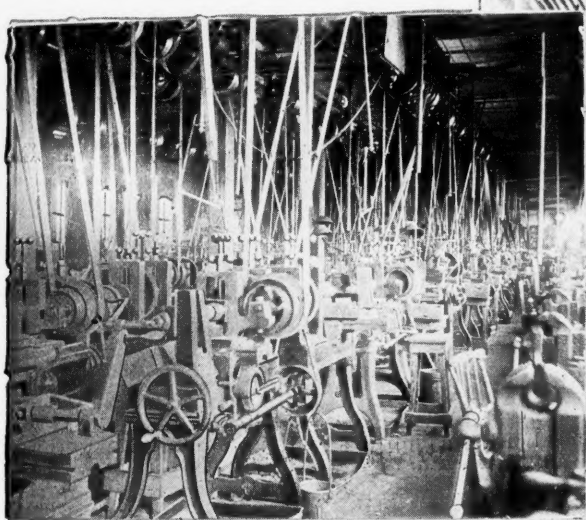


FIG. 7.—LINCOLN MILLERS.

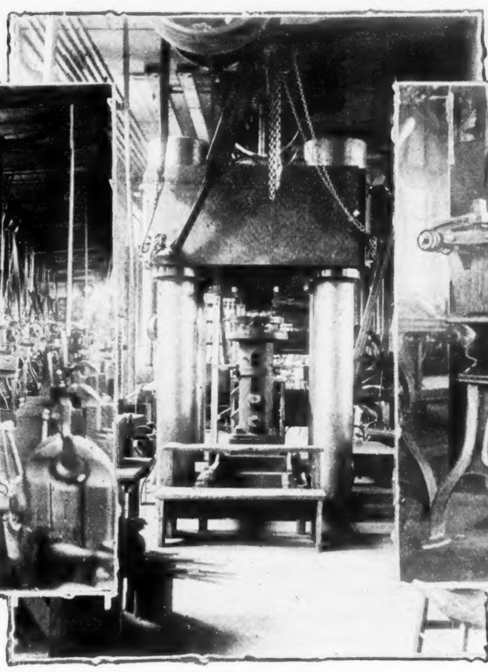


FIG. 8.—HYDRAULIC PRESS—4 TONS.
WINCHESTER ARMS COMPANY.

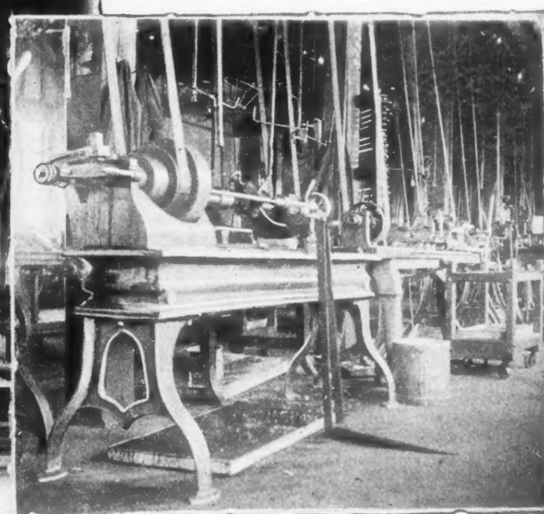


FIG. 9.—THREADING BARRELS.

of the barrels. They are not unlike fox lathes in operation, the chasing bar having an arm carrying a "leader," as shown at the left, which fits a threaded hob or former. The chasing tool is held down by hand (and foot if necessary, as shown by the strap and foot piece), and the whole operation greatly resembles fox lathe work, with which we suppose most of the readers are familiar. There is much other interesting machinery employed in gun making, most of which is specially made for each factory after its own designs, and which they consider as private property. The rifling machinery, the machines which measure out exact quantities of powder and shot and load them into a shell, stamping the exact load on the outer wad, and even the machines for making the paper boxes for shells, are all interesting to the mechanic or student of mechanisms, and they also explain how we can buy shells, loaded more accurately than we can load them ourselves and for less money. It further shows, and there is considerable satisfaction to the mechanic in knowing it, that there is hardly a business or part of a business that does not depend on the mechanic for its success. Even the farmer needs tools, and from this up to the bond clipper in the top story of an office building, the hand of the mechanic is everywhere visible.

* * *

PATTERN-MAKING MACHINISTS.

It may seem like an old and worn-out subject to say "Keep your tools sharp," to those machinists who like myself enjoy butchering a block of wood until it resembles the shape of something we want cast in the sand; but there is more to it than appears at first sight. Nothing grates on the nerves of a good pattern-maker more than to see some metal doctor like me tackle pattern-making, and use gauge, chisel, rasp and file (principally the latter) till it is done and ready for the moulder to groan over (or worse) when he attempts to draw it out of the sand.

A pattern-maker once told me, in language more forcible than elegant, that if I'd keep my tools *sharp* I wouldn't need use a rasp and file so much; and I find there's considerable in what he said, though I haven't discarded my file by any means—very handy at times.

* * *

NOVELTY vs. ECONOMY.

Many mechanics seem to think it necessary to invent new movements, to use new designs and to be able to say "I designed everything about that machine and its all new." As a matter of fact it seldom is entirely new, and even if it were, it does not imply any superiority. While the endeavor to be original is highly commendable, there is such a thing as carrying it too excess, and better tools would sometimes be produced by giving more attention to construction on well known lines than to novel devices which are no better it not worse. The correct application of old principles and devices, if they are mechanically sound, is of even more value in economical shop management and production than the attempt to produce something entirely novel in construction details. When the old method is not satisfactory it is time to find a new one, but it is not advisable, from any standpoint, to make changes in design without cause, or unless there is a real objection to the old more than the mere fact of its being old. To sum up in a few words it is better and more economical to utilize old and tried principles than to attempt too much originality in design.

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THE TRADE IS SUPPLIED BY THE AMERICAN NEWS COMPANY OR ITS BRANCHES.

JUNE, 1896.

MOST of our knowledge is gained from the experience of others, which has the one great drawback—that we do not usually know all the conditions existing when the information was obtained.

IN ALL AMERICA.

Messrs. Geo. P. Rowell & Co., publishers of the American Newspaper Directory, for twenty-eight years the standard authority on newspaper circulations, make the following statement regarding MACHINERY:

"In all America no other paper devoted to machinery has credit for so large a circulation as is accorded to *Machinery*, published monthly at New York; and the publishers of the American Newspaper Directory will guarantee the accuracy of the circulation rating accorded to this paper by a reward of one hundred dollars, payable to the first person who successfully assails it."

This is not a paid advertisement; it is their voluntary and unsolicited statement, without request or compensation from us, based on the circulation of this paper for the twelve months ending and including January, 1896, during which period the average circulation was 14,958 copies each issue. To the best of our knowledge and belief this circulation was about fifty per cent. greater than that of the *American Machinist*, and more than double that of the *Iron Age*, for the corresponding period. This statement is made with no intention whatever of assailing the high reputation and leading position which these well-known publications have held for many years; but simply as a basis of comparison for our readers, many of whom may not realize what a circulation of 15,000 means for a trade paper.

* * *

HIGH SPEED ONCE MORE.

Another revolution is about to take place in the railroad world; for, according to a local paper, the problem of high speed has at last been solved by a resident of Quebec. Strange to say this is not to be effected by a new motor of 108 per cent. efficiency, but by alleged new rails and trucks for the cars. The rail consists of what is apparently a cable road conduit, containing the wheels at more or less frequent intervals. while the car truck is merely a sort of snow-shoe, running on the aforesaid wheels, being attached to the car through the slot at the top; in fact, the runner is practically dovetailed into the slot, which, of course, prevents it from going on any cross-country excursions as long as the snow-shoe stays fast to the car.

This should be hailed with joy by car wheel men, as there would probably be in the neighborhood of 2,640 wheels required to the mile, allowing four feet between centers. But it would, of course, have the advantage of doing away with hot boxes, as each wheel would be in action a very short time, especially at two or three hundred miles an hour.

These rails would also be slightly expensive, while the openings at the top would make good dirt traps; and if, as shown in the illustration, they rested on ties above ground, could be used either as hurdles by fox hunters, or as fortifications by the government in case of war, for they would loom up like a line of coast defences if a respectable size wheel was used—perhaps they intend using castors or silver dollars.

One feature which is not explained is the method of propulsion. As the ordinary locomotive or electric motor has never been trained in the roller coaster or toboggan business, it seems somewhat doubtful about the moderate speed of two hundred miles per hour being attained by any motor on the snow-shoe apology for a truck, and we do not think that even the inventor is so far on the road toward lunacy as to think of driving all the wheels hidden in the rails and driving the car through them. This leaves us but two motive powers, the festive mule and the ever breaking cable, for neither depends on the tractive power of the rail. As with most of the extremely high speed schemes, this is neither new nor practical, and the only excuse for devoting so much space to such a monstrosity lies in the hope that some one with more money than mechanical ideas may be saved from a foolish investment. Let them save their money for some better scheme.

THE HYPERBOLIC CURVE—VARIOUS METHODS OF CONSTRUCTING IT.

M. E.

The rectangular hyperbola is now so largely used as a reference standard with which to compare actual indicator diagrams, that the following brief description of several different methods of constructing the curve may, it is thought, be found of service in this connection. No attempt is made to scientifically trace the relationship between the various methods of construction, but each is simply explained and doubtless each particular plan will appear to some to be preferable to the other methods described.

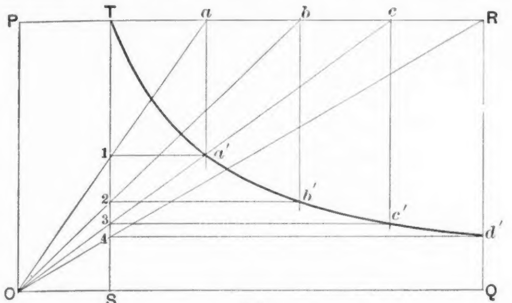


Fig. 1

Probably the method shown in Fig. 1 is one of those most frequently adopted. Here O P and O Q are the clearance and vacuum lines respectively; S T is the cut-off ordinate and it is required to draw an hyperbolic expansion curve passing through the point of cut-off T.

Method 1.—Draw through T the line P T R parallel to O Q and meeting the terminal pressure ordinate in R. From O draw a series of radial lines as shown cutting S T in 1, 2, 3 and 4, and P R in *a*, *b*, *c* and *d*. From 1 draw a line parallel to O Q and from the corresponding point *a* in P R drop a perpendicular. The point of intersection of these lines gives *a'* one of the points

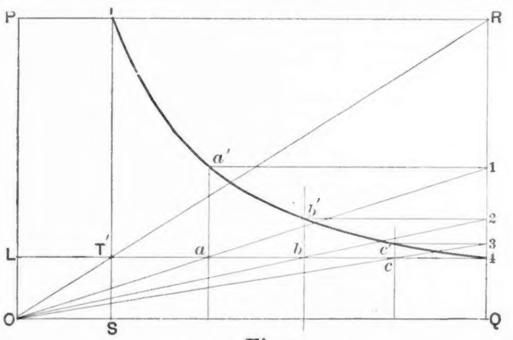


Fig. 2

through which the curve must pass. Proceeding similarly with the other radial lines, the points *b'*, *c'* and *d'* are obtained, through which the curve may be drawn. It is to be noted that any number of radial lines may be drawn from O and at any distance apart; also that they need not be drawn so as to give regularly spaced ordinates as in the figure.

In order to readily construct the hyperbola by this method the card should be pinned on ordinary board so that the line of absolute vacuum O Q is horizontal. Then by the aid of the T-square of triangle, the curve may be readily drawn in.

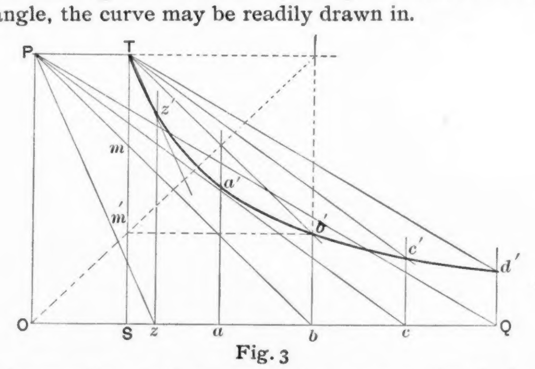


Fig. 3

It is frequently required to draw the curve so that it shall pass through a point at or near the point of release, in which case the cut-off ordinate not being available the method shown in Fig. 2 may be employed.

Here we assume that the curve is to be drawn through the point 4, on the terminal pressure ordinate Q 4.

Method 2.—Draw through 4 a line 4 L parallel to O Q. Produce the ordinate Q 4 upward and draw a series of radial lines from O cutting L 4 in T', *a*, *b* and *c*, and Q R in R, 1, 2 and 3. Then through *a* draw the ordinate *a a'* and from the corresponding point 1 draw a horizontal as shown. The meeting point *a'* of these lines gives one of the points in the required curve. Proceeding in a similar manner to determine *b*, *c* and T, the complete curve may be drawn in as before. As in the previous case, the lines from O may be selected at random and of course any number may be used.

The method illustrated by Fig. 3 appears to be a distinct departure from those previously described, but on close examination it will be seen to depend on the same properties of the curve. Here again it is required to draw an expansion curve through the cut-off point T.

Method 3.—Draw any number of ordinates as *a a'*, *b b'*, etc., which may be either regularly or irregularly spaced. From P to

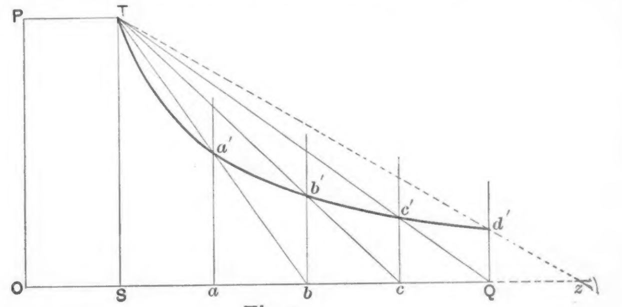


Fig. 4

the base of each ordinate, as *b*, draw a line *b* P. Parallel to this line draw a line from T intersecting the ordinate *b b'* in *b'*, which latter is one of the points in the required curve. In a similar manner the other points 1' *a'*, *c'* and *d'* may be obtained and the curve drawn.

It will be noted that this method of procedure may be shortened somewhat by the aid of a pair of dividers. Thus instead of drawing T *b'* parallel to P *b*, the desired end may be readily attained by taking the distance T *m* in the dividers and setting this off from *b* on the ordinates *b b'*; for obviously T *m*=*b b'*

The connection between Methods 1 and 3 will now be evident, since it is clear that by making the lines radiate from O, and in an upward direction, all such lengths as T *m* will appear as S *m*, and may therefore be projected directly by drawing the horizontal *m b'* until it meets the ordinate in the required point *b'*. The construction shown in Fig. 4 is very similar to that just described.

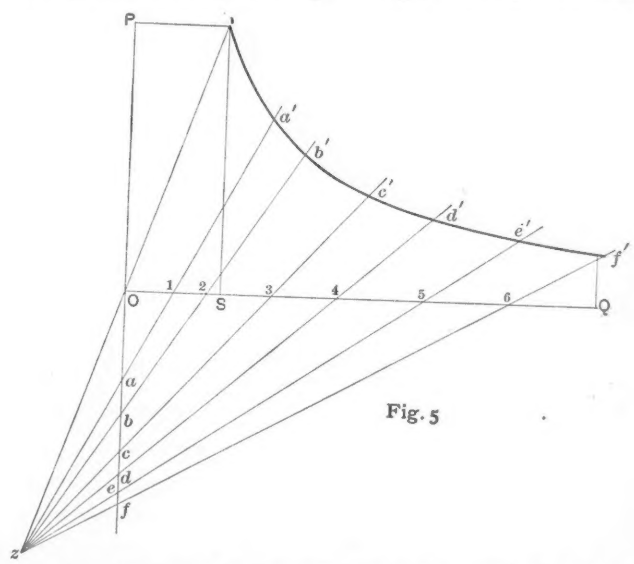


Fig. 5

Method 4.—On the line O *z* erect a number of ordinates *a a'*, *b b'*, etc., such that the distance between each is equal to the *real* admission period O S. Then from T draw a series of lines to the bases of the several ordinates as shown. The point *a'*, in which T *b* intersects *a a'*, is a point on the curve; and *b'*, *c'* and *d'* being similarly determined, the curve may be drawn. Although given in one or two standard works of reference as a convenient method of constructing the hyperbolic curve, the writer considers this plan the most unsatisfactory of any. It will be evident that with a late cut-off only very few ordinates could be used, while for that

part of the curve between T and a', no points of guidance are available.

The method illustrated by Fig. 5 deserves to be better known. It is largely employed by French and German writers and possesses some points of advantage over most of the other methods. In this case it is unnecessary to draw ordinates; in fact the only line needing accurate drawing is P O f, which must pass through

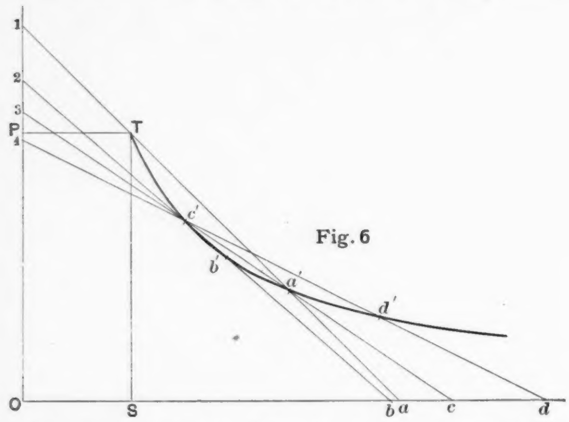


Fig. 6

O and be perpendicular to O Q. In most cases, therefore, the card need not be pinned to a drawing board—often an advantage of considerable moment.

Method 5.—From the point of cut-off T draw a line through O prolonging it to Z, such that O Z=O T. From the point Z thus found, draw in any direction any number of radial lines as shown, cutting O f in points a, b, c, d, e and f and O Q in points 1, 2, 3, 4, 5 and 6. From 1 lay off a length 1 a'=z a, thus obtaining a',

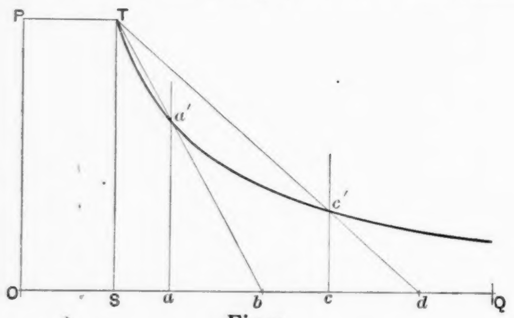


Fig. 7

one of the points on the required curve. Similarly lay off 2 b'= z b, obtaining b', and proceeding in this manner any number of points in the curve may be very readily determined.

Another method of drawing the hyperbola, and one moreover which can be used to draw a curve through any given point is shown in Fig. 6. We will assume that, as before, the curve is required to pass through the cut-off point T, but as will be readily seen, the method is equally serviceable no matter where the initial point may be located.

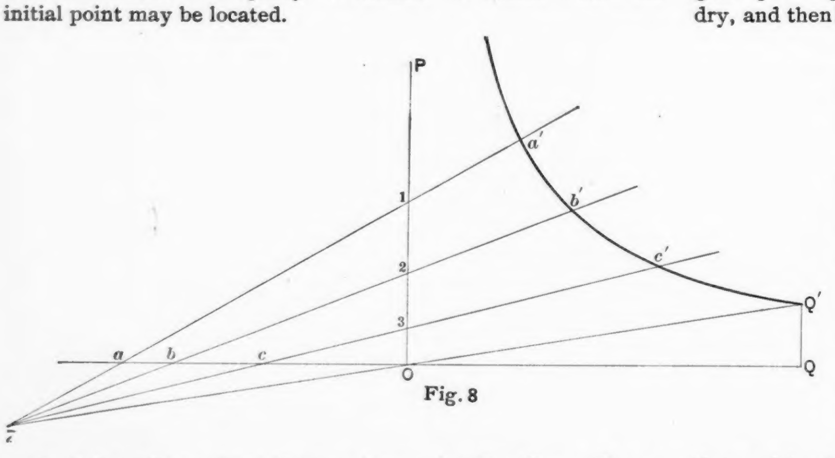


Fig. 8

Method 6.—Draw through the given point T a line 1 T a at any convenient angle with o d. From a lay off on this line a length a a'=T 1, thus obtaining a', one point in the required curve. Through the point so found draw a line in any other convenient direction, as c a' 3, and on this line lay off from 3 a length 3 c'=c a, obtaining c', a second point in the curve. Through c' draw b c' 2 and on this line lay off from b a length b b'=c' 2, which will give b'. Any number of points may be quite readily determined in this manner and the curve drawn.

As will be seen, there is a considerable choice of methods of drawing the hyperbolic curve, and the particular plan selected in any case will depend more upon individual taste than upon any very marked superiority of any one system over the others. At the same time the writer would say that he has found it advisable to adhere to one method of procedure, and that generally the simple method of obtaining a point on any ordinate (as c c', Fig. 7) by stepping off c d=P T and cutting a a' by the line T d, thus locating c'—is on the whole sufficient to meet all requirements. If it is desired to avoid drawing ordinates the plan shown in Fig. 5 is preferable provided the point through which the curve is to pass is at or near the cut-off point. If the point is at or near the lower extremity of the curve, the modification shown in Fig. 8 may be used. Here Q' is the given point, and by drawing Q' O Z and making O Z=Q' Z, the point Z is obtained, from which lines are drawn as shown and the points a' b' c' found precisely as in Method 5.

* * *

DRAFTSMEN'S TRIANGLES.

The triangle is one of the most useful things that a draftsman can have about his board; and all sizes are convenient, from 3 inches to 18 inches and even 24 inches high, according to the work to be done.

The principal trouble with them when they are framed up of wood as shown in Figure 1 is that they are apt to come apart.

This difficulty will be lessened by letting into each of the

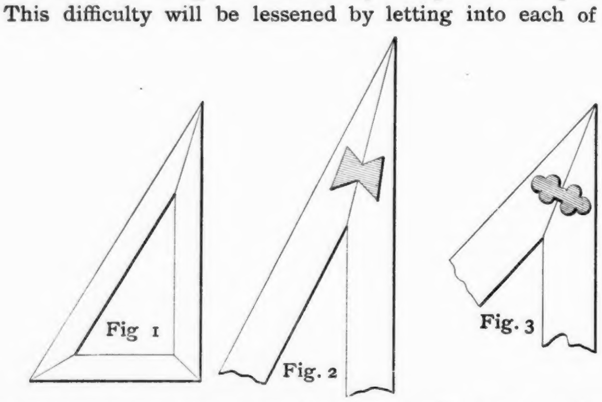


Fig 1 Fig. 2 Fig. 3

angles dovetail pieces of double clover-leaf pieces, making a joint as shown in figures 2 and 3. These dovetails may be made of wood or of sheet metal.

Solid triangles have the disadvantage that their corners break off unless they are handled with great care by the owner and all others. This may be got around by gluing together two of them with the grain running at right angles, and then planing them down or running them through a sand papering machine.

This plan of gluing up two ready-made triangles will of course work only with those of 45°. Where it is desired to have them of 30° and 60° or any other angles, all that is necessary to do is to glue up two pieces of veneer, keeping them in the clamps until dry, and then laying down on them the lines to which it is desired to work, to cut out the desired size and shape with a band saw or a book-binders paper-cutting knife; finishing up on a shuteing-board such as is used for mitre joint.

If it be desired to improve a triangle already on hand, glue on both sides some stout linen or muslin. This will greatly increase the friction on the paper, which is for some work an advantage and for others a disadvantage; but the corners will not be likely to break off through falls, &c.; and the friction may be brought down to less than normal by driving in on each side three ordinary brass pins, cut down to a length rather less than the thickness of the triangle. The heads will make bearing-points; and this treatment may be recommended for all sorts of triangles, especially for those of hard rubber, which have a habit of soiling the paper.

Where two triangles are glued together with grain at right angles and then cut down, if the hanging-holes "come blind" the trouble may be very readily remedied by a Forstner (Bridgeport) bit, with which it is perfectly safe to bore anything without fear of splitting.

And now as to special angles, There are several which come in very handy; and what they are depends on the nature of the work. Hardly any two establishments will require the same extra

angles. Whatever they are, they may be very readily obtained by cutting them out of the solid triangles, especially those made of hard rubber, or of two thicknesses of wood glued together. Fig. 4 shows an extra set of three angles secured in this way,

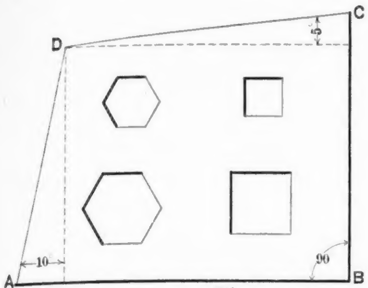


Fig. 5

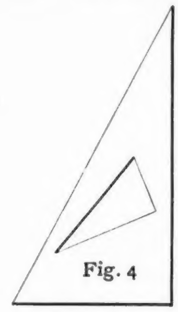


Fig. 4

without the necessity of cluttering up the board or tool drawer unnecessarily.

In addition to the triangle it will be well to have within reach other wooden, hard rubber or transparent celluloid pieces having cut out of them forms which are often needed for hasty sketches,

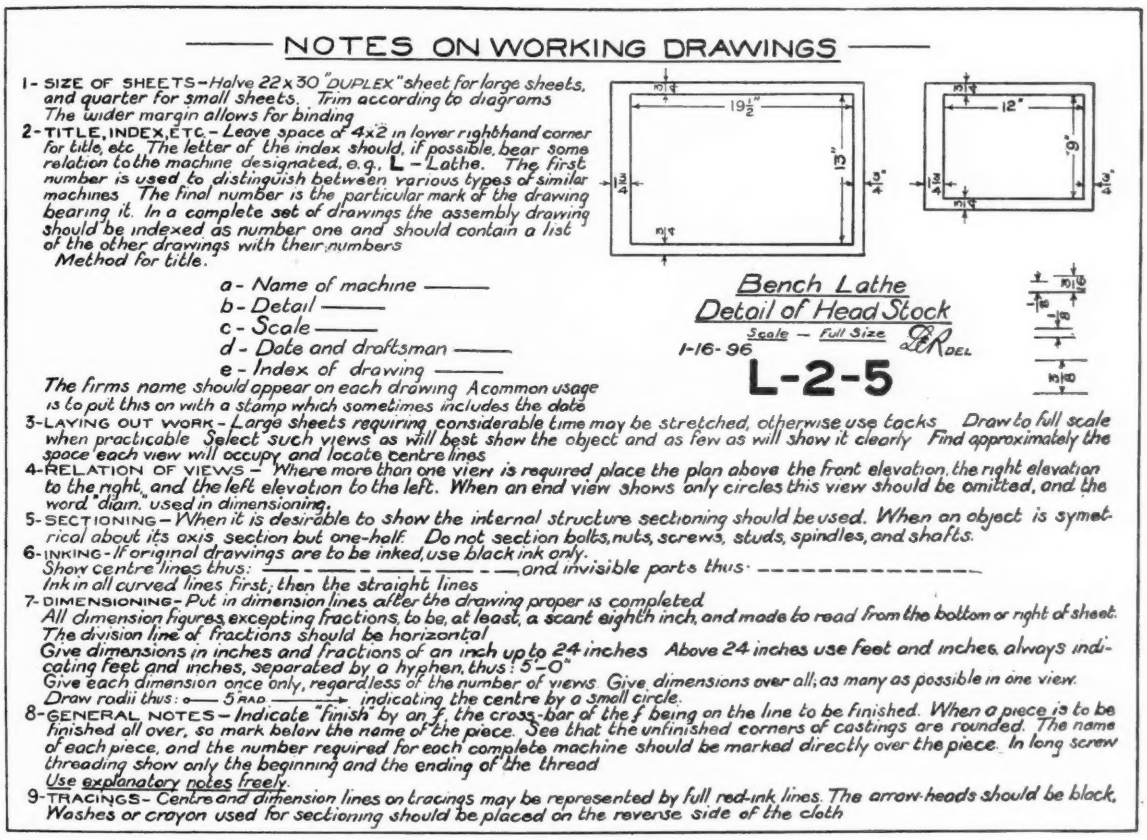
PRACTICAL TALKS ON MECHANICAL DRAWING.—(7).

Louis Rouillion.

SHEETS XXV. AND XXVI.

Practice in the various drafting rooms may differ in details, yet is uniform in principles. These principles we have been studying in the previous sheets of the course, and are about to apply them in making a complete set of working drawings of a bench lathe. For the sake of compactness, and the arranging of a series best adapted for students' use, the set is made up of five sheets, the first of which is an assembly drawing, and the remaining four being each a detail sheet of the four parts of the lathe—the head-stock, tool-rest, tail-stock, and bed. Other arrangement of sheets might advantageously be made. For example, all work for the forge shop might be grouped together, and also all work for the pattern-maker. In fact, it is the custom in some drafting-rooms to make separate drawings for the machinist, the pattern-maker and the blacksmith. Or all work required to be done on a certain machine, as a screw-cutting lathe, may be brought together.

Another commendable custom that obtains in some of the


NOTES ON WORKING DRAWINGS

1- SIZE OF SHEETS—Halve 22 x 30 "DUPLEX" sheet for large sheets, and quarter for small sheets. Trim according to diagrams The wider margin allows for binding

2- TITLE, INDEX, ETC.—Leave space of 4 x 2 in lower righthand corner for title, etc The letter of the index should, if possible, bear some relation to the machine designated, e.g., L—Lathe. The first number is used to distinguish between various types of similar machines The final number is the particular mark of the drawing bearing it. In a complete set of drawings the assembly drawing should be indexed as number one and should contain a list of the other drawings with their numbers

Method for title.

a - Name of machine ——
b - Detail ——
c - Scale ——
d - Date and draftsman ——
e - Index of drawing ——

The firms name should appear on each drawing A common usage is to put this on with a stamp which sometimes includes the date

Bench Lathe
Detail of Head Stock
Scale — Full Size
1-16-96 L.R. DEL
L-2-5

3- LAYING OUT WORK—Large sheets requiring considerable time may be stretched, otherwise use tacks Draw to full scale when practicable Select such views as will best show the object and as few as will show it clearly Find approximately the space each view will occupy and locate centre lines

4- RELATION OF VIEWS—Where more than one view is required place the plan above the front elevation, the right elevation to the right, and the left elevation to the left. When an end view shows only circles this view should be omitted, and the word "diam." used in dimensioning.

5- SECTIONING—When it is desirable to show the internal structure sectioning should be used. When an object is symetrical about its axis section but one-half Do not section bolts, nuts, screws, studs, spindles, and shafts.

6- INKING—If original drawings are to be inked, use black ink only.
Show centre lines thus: — - — - — - — - —, and invisible parts thus: - - - - - - - - - - - -
Ink in all curved lines first; then the straight lines

7- DIMENSIONING—Put in dimension lines after the drawing proper is completed
All dimension figures, excepting fractions, to be, at least, a scant eighth inch, and made to read from the bottom or right of sheet.
The division line of fractions should be horizontal
Give dimensions in inches and fractions of an inch up to 24 inches Above 24 inches use feet and inches, always indicating feet and inches, separated by a hyphen, thus: 5'-0"
Give each dimension once only, regardless of the number of views. Give dimensions over all; as many as possible in one view.
Draw radii thus: o— 5" RAD —→ indicating the centre by a small circle.

8- GENERAL NOTES—Indicate "finish" by an *f*, the cross-bar of the *f* being on the line to be finished. When a piece is to be finished all over, so mark below the name of the piece. See that the unfinished corners of castings are rounded. The name of each piece, and the number required for each complete machine should be marked directly over the piece. In long screw threading show only the beginning and the ending of the thread
Use explanatory notes freely.

9- TRACINGS—Centre and dimension lines on tracings may be represented by full red-ink lines. The arrow-heads should be black. Washes or crayon used for sectioning should be placed on the reverse side of the cloth

PRACTICAL TALKS ON MECHANICAL DRAWING.

as bolt-heads and other "hex" outlines and having angles corresponding to screw-threads and other lines which run at angles slightly inclined to the usual lines of a drawing. Figure 5 shows a very useful piece for any one who has to draw many conventional screw-threads. The angle B may be 90°; the line C D inclined 5° to A B, and A D 10° to B C. E is the outline of a square bolt-head or nut of the size most often wanted, and F that of the hex bolt-head or nut that is most often laid down on the board.

A logarithmic spiral curve is a very useful piece, as every draftsman will find it will fit almost any common curve that he may want; and by it also calculations may be made by those who understand its use.

* * *

The town of Lexington, Mass., is about to lose one of its landmarks, not of revolutionary fame, however, unless we count the many successful revolutions made by the gears turned out by the Grant Gear Works of that town. To better handle the jobbing trade they are about to move to Boston, Mass., and wish to lease or sell their present plant, which is eleven miles from Boston, and well adapted for any business not dependent on the Boston jobbing trade.

larger offices is the epitomizing of the office's practice in a "Sheet of Instructions." The accompanying "Notes on Working Drawings" is an example of this usage. The student should thoroughly familiarize himself with these notes. They will now be considered, one at a time, in the order given.

1. Size of Sheets.—The larger sheet, having a "sight" of 19½ by 12 inches, is used for the set of lathe drawings.

2. Title, Index, Etc.—The reason for placing the title in the lower right-hand corner is, that as the drawings are usually filed by putting them in a shallow drawer, any particular drawing may be readily found by turning up the corners of the sheets. This suggests another method of indexing. Supposing one hundred drawings are filed in each drawer. Then, by putting the number of the drawer upon each drawing, together with its numerical order, a ready method of cataloging is obtained. The placing of a complete list of the drawings for a machine upon the assembly drawing affords another method of finding any particular drawing desired.

3. Laying out of Work.—This is a matter of experience, and can best be done only after considerable practice.

4. Relation of Views.—This question was dwelt upon at some length in Sheet III. When but one view of a circular object is

shown, and that a view not showing a circle, "diam." or simply "D" may follow the dimension when there is any doubt about the shape of the object.

5. *Sectioning*; 7. *Dimensioning*; *and* 9. *Tracings*, require no further explanation.

6. *Inking.*—Sometimes dimension lines are shown in red ink, and blue ink is sometimes used for center or construction lines. If all such lines are made lightly, the use of black ink alone commends itself.

8. *General Notes.*—"Finish" should not be indicated where the ordinary process of manufacture results in a finished surface, except upon pattern-makers' drawings. A good way of showing surfaces to be finished is by drawing a line in red ink adjacent to such surfaces.

The designing of a machine and the making of the original drawings for it is not a subject to concern the student of elementary mechanical drawing. That is the work of the experienced designer and draftsman. The best practice for the student is to make drawings of some machine already built. Supposing the bench lathe under consideration to be such a machine. The first thing to do is to take the machine apart and make careful free-hand sketches of each part, fully dimensioning. These sketches should be such that, if necessity demanded it, the parts might be made directly from the sketches. Section paper, a paper lightly lined to inches and fractions of an inch, will be found of assistance in making correctly proportioned sketches. From these sketches the mechanical drawing is made in pencil, and may or may not be inked. As every one cannot have a machine to take apart and make sketches of, the student may treat the accompanying sheets as sketches and make his drawing directly from them, working from the given dimensions. Begin with the detail sheet of the head-stock. Next month the detail of the tool-rest, tail-stock and bed will be given. The assembly drawing should be made last, and the dimensions taken from the detail sheets. The numbers upon the assembly drawing refer to the numbers of the various parts and show how they are assembled. For example, the head-stock frame in the assembly drawing is marked "2-1." By looking at the "List of Drawings" it will be seen that "2" is the number of the sheet containing the details of the head-stock, and that the number of the frame is "1" on that sheet. Again, the hand-wheel on the tail-stock is numbered "4-6," which means detail number 6 on sheet number 4.

The front cap of the head-stock in the assembly drawing should be marked "2-13" instead of "2-12" as given.

EXERCISES 25-29.

If the student has a small machine at his command, good practice may be obtained by making a set of drawings for it.

Or, sets of drawings for the machinist, pattern-maker and blacksmith, may be made from the complete drawings of the bench lathe.

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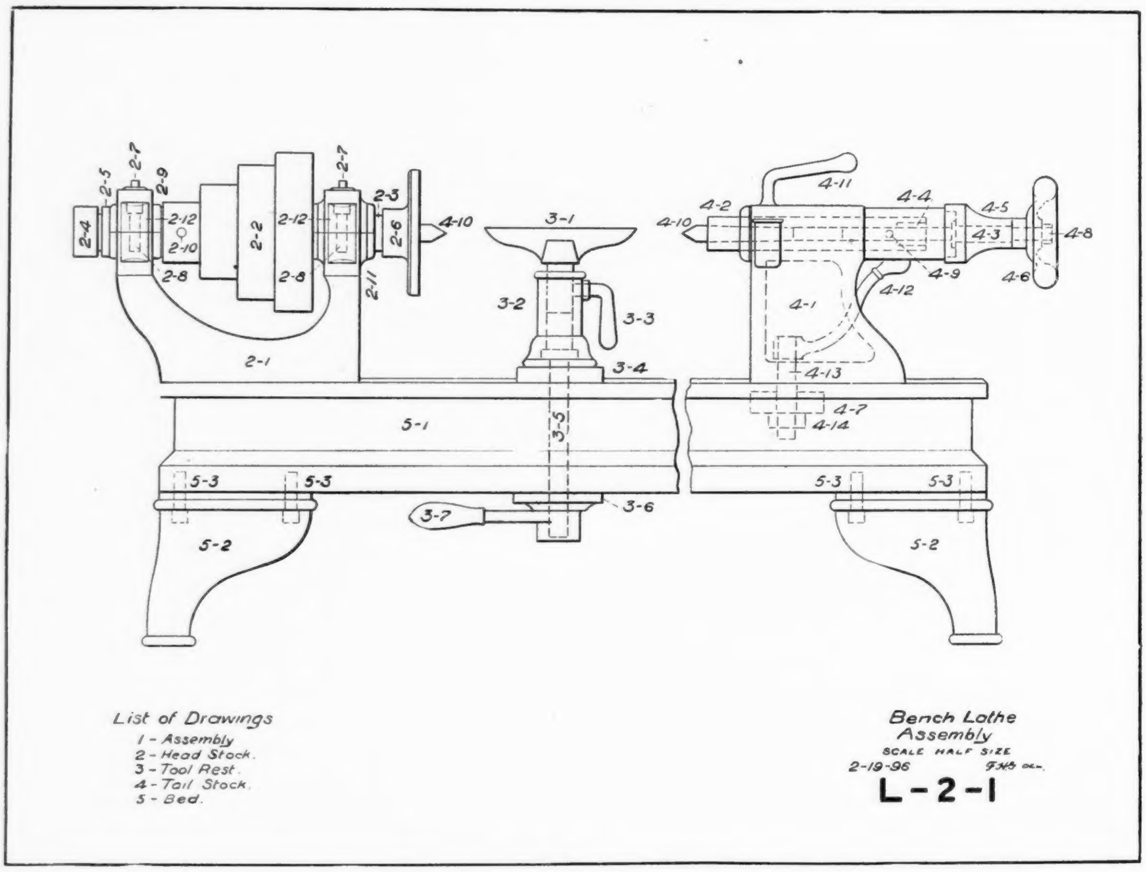


PRACTICAL TALKS ON MECHANICAL DRAWING.

PUTTING ON VALVES.

PETER H. BULLOCK.

The question is frequently asked as to the proper way of putting on a globe or angle valve, whether the pressure should be on top or under the seat. It is usually answered to put the pressure under the seat so that the stem may be packed when the valve is closed. On general principles the above answer is right, but most rules have their exceptions, and there are cases where it is best to have them on the other way, as, for instance, where it is found necessary or expedient to use a globe or angle valve in the feed-pipe to a boiler, in which case it is best to put the pressure *from the pump* under the seat, and then if the disc becomes detached the pump can still force water into the boiler, and if the valve is in such a position that the disc will retain its place it simply becomes another check valve. I believe it best to use gate valves for such work, but if globe valves must be used, by all means get good ones.

If globe or angle valves are used for main stops between boiler and steam mains they should always be placed with the pressure from the boiler under the seat, for then if the disc becomes detached the pressure will push the valve open when the stem is turned back, as it can be pushed on to its seat by turning the stem down against it. Not long since one of a set of five boilers under my charge, that are connected to the steam main by angle valves, was found to be in the above condition, and it was only by accident that it was discovered. A grate in the furnace of this boiler got broken, and the fire was pushed to the sides in order to get a new section in place. While this was being done I noticed a fall of about 5 pounds in pressure from what the other boilers showed. As the stop valve had not been closed it occurred to me that the disc must be detached from the stem of the main stop, and was acting as a check, preventing steam from other boilers

keeping the pressure even. At the earliest opportunity an examination was made and this found to be the case. I have no means of knowing how long it had been in this condition, but being on as it was, made it automatically safe, for had it been on the other way and the steam from any reason had gone up, there would have been no way to get it out of the boiler except *via* safety valve.

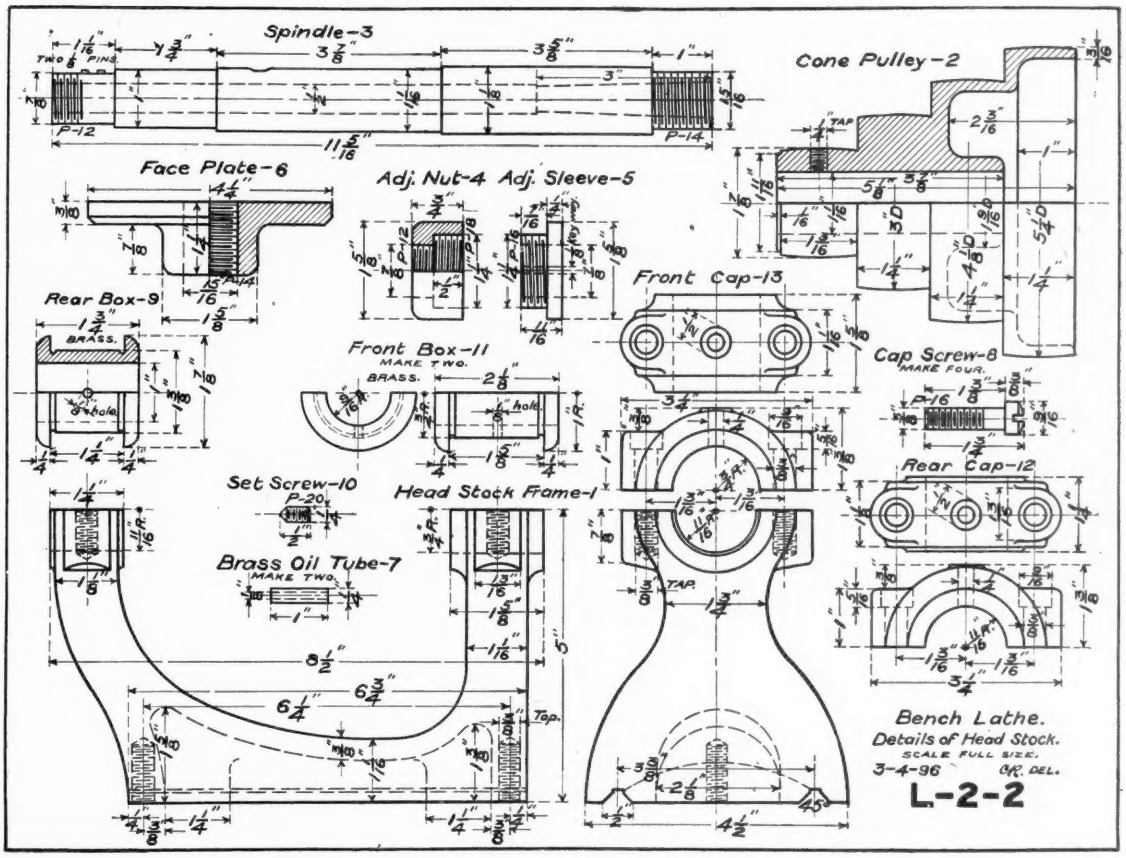
Accidents will also happen to gate valves. The stem may break or twist off inside the bonnet, either when the valve is open or closed. If this happens when the valve is closed and the seats are tight, the bonnet may safely be removed even with pressure on the pipe, and the necessary repairs made, as there is no pressure or thrust at right angles to the pipe to blow the seats out. Some years ago I had a peculiar accident happen to a 10-inch water gate which it became necessary to open and close several times in one day while connections were being made. Finally when it was to be opened at the completion of the job, no water would pass through the pipe. The wrench could be turned the necessary number of times (about sixteen, I think) and the stem would then bind as if the gate was seating in the usual way. After much vexatious delay the gate was dug up, the bonnet and *one* of the discs was found to be broken from the central nut frame and was firmly on its seat, while the other had been moving up and down, as we had turned the stem, as if nothing was the matter.

I don't know whether I have more trouble with valves than other people or not, but in a plant where there are several thousand, many of them in use every hour in the year, there is hardly a day passes but what some are giving out, and seats getting off from their stems is one of the most frequent causes of trouble.

* * *

MARKING STEEL TOOLS may be done by covering them with wax, engraving the marks through the wax down to the level of the steel, and then etching with the following mixture: 1 ounce of sulphate of copper, 1¼ ounces of alum, ½ teaspoonful of salt reduced to powder, with one gill of vinegar and 20 drops of nitric acid.

IN BORING CYLINDERS it is better to use three cutters than one or two. With one cutter there is spring to the bar. With two the bar is not so well supported as with three. One cutter will cause the hole to be smaller in the middle than at the ends of the cylinders, and the surface of the metal will be rougher in the middle than at the ends of the cylinder.



FRACTICAL TALKS ON MECHANICAL DRAWING.

NOTES FROM NOTOWN.—12.

THE SHOP FAVORITES AND CLIQUES—FREEZING JACKSON OUT.

ICHABOD PODUNK.

There are perhaps few large shops that are not afflicted with the disease of favoritism. In some shops it is like a slow fever, from its being kept at a low point by careful restraint on the part of the superintendent; in others it is of the quick consumption type when allowed to run rampant. In either case it is a fatal malady, sapping the life of the firm, financially injuring the men who are out of the clique, and just as surely hurting those who are favorites by disqualifying them for places when no favoritism is shown. I presume many will say this is overdrawn, so a few facts may be of interest.

Here in Notown we have horrible examples of this in the Notown Engineering Works, where they build engines for electric and other work (the best engine built, of course). The superintendent holds his position by virtue of a friendship with the original proprietor, whose clerk he formerly was, his main qualification being that he knew—or pretended to at least—the foundries where the different patterns had been kept and could find any pattern wanted; but in reality it often took him a day to do it. Any one with half a head can see that a pattern book and a little bookkeeping could have kept better track of these than even Mr. Swift could by carrying all the patterns in his head; needless to say he had a large head to be able to do this. His head foreman is of the same type, only with a smaller head; and what he doesn't know about modern machine shop practice, or even ordinarily good work, would fill several copies of this paper. He is a hustler—sometimes, when the man who is hustled isn't a favorite—but he was never known to get a job out on time, because he wouldn't have the work come along together, but had whole machines waiting for some little part to be made.

These two head favorites had others under them, and "the gang," as it was called, got all the extra work there was to be done. The best planing work was given to Fitz, who by the way couldn't plane a valve so it would lay still after he took it off the planer, but this made work for Jim, the scraper, who was also in the gang, so there was no objection on his part. Any extra work went to these men as a matter of course, and their endurance was wonderful, as they could work all night (according to their

time cards) five nights a week, and be at their posts the next day as well, which made a very handsome addition to their pay roll—at the firm's expense. No man can *work* such long hours as these; they may *stay in the shop*, but working is another thing. Night work is an expensive amusement at best; under these conditions it is highway robbery.

The effect of this method on the other men is not apt to produce good results; they see that "the gang" get the work, the money, and about all there is desirable, and they naturally do not feel deeply interested in their work or the welfare of the company. Under these conditions, with plenty of orders in hand, it is little wonder that the Engineering Works are in the hands of a receiver.

The Electrical Mfg. Co., who occupy part of the same building, are on a somewhat similar road, although they haven't reached the receiver point as yet, but they are getting there in a hurry. Here the heads of departments know a little more than the ones just mentioned, but the fact that one came from the original company and the other from the company which consolidated with it, makes merry war between them at the expense of the Electrical Mfg. Co. Favoritism here depends on the geographical antecedents; if he comes from Kalamazoo he doesn't stand any show from the superintendent; and if he hails from Notown or has any claim on the place, the general foreman has it "in for him," as the boys say. This is a condition of affairs not tending to increase the dividends of the company, and shows that harmony —with a big H—is necessary for the best results in any shop, and it should extend from the manager, through the drawing room, pattern shop, foundry and machine shop, if the most economical output is considered.

One of the most white livered games a man can play, whether he be superintendent or only a helper, is to throw obstacles in another man's way, or in bicycle language, "Strewing tacks in the way of his pneumatic tire, causing a puncture, whereby his wind escapeth him and he comes to earth," etc. This is much more apt to be the case where a man has a favorite whom he wishes to push ahead and wishes some excuse for doing so. That this is easy to accomplish can be readily seen by anyone familiar with shop practice, and is too well known by the many victims who have not only been displaced and forced to seek other positions, but have had their reputations unjustly tarnished, which does not add to the prospects of obtaining another good position.

A friend of mine was engaged as tool-maker by a large concern who were making special machines which required great accuracy of construction. His good work attracted the attention of the superintendent, and he was advanced to more responsible positions until he finally became assistant superintendent, and had brought order out of chaos, had designed jigs which not only made accurate work possible, but which largely increased the production, had in short established the plant on a modern basis which the super himself had not been able to do. The super knew this, and also knew that he couldn't get along without Jackson for an assistant. I suppose that cold-blooded ethics would say that Jackson should have been made super, but the millenium hasn't arrived yet, and we don't expect a man to step out of a cushion chair position to let some one else step in, unless he has to.

The company underwent several changes, and the super had to walk the plank to make room for another favorite of about the same stamp, but who, unfortunately for Jackson, also had a favorite whom he wished to make his assistant. Instead of being square about it and telling Jackson he wanted his place for his second-wife's-first-cousin-by-marriage-on-her-mother's-side, he commenced throwing tacks around for Jackson's tire to run over —threw them so thick that Jackson couldn't avoid them if he rode at all, and he had to ride. Foremen were given instructions counter to Jackson's orders, simply to create dissensions, and the foremen soon understood that Jackson was fast becoming a fifth wheel; so, to make their own positions secure, sided with the new super.

As Jackson didn't seem to know enough (in the super's opinion) to resign, more severe measures had to be taken to accomplish the threat "to drive the Yankee out," and the jigs were ordered out of use and new ones rigged up. This gave Jackson a chance to kick, because he took considerable honest pride in those jigs, and he was fired for "insubordination"—that word looked better on the the super's report than it would to say "Frozen out to make room for my wife's first cousin," etc. To cut a long story short, the old jigs were put back into commission and are in use to-day, which proves Jackson's right to a pride in them, but his reputation was injured, as the books of the company said "Dismissed for insubordination," and several letters from the super to persons who desired Jackson's services contained about the same cheerful information, something like this: "Mr. Jackson was a fair workman and we have nothing special to say *against* him except that he had to be dismissed for insubordination."

There is probably no law that would touch such a case, even if one was desirable, but work of this kind is just as much robbery as though you stopped a man with a club, and not only went through his pockets, but crippled him so he couldn't earn anything more. I don't consider a fat purse as exactly trash, even if the old saw does say so, but even a mechanic's reputation ought to be respected when it so seriously affects his getting a job, and while it may all come out right in the end, a fellow can't live on wind pudding with air sauce until the desired end arrives; his own end having the best chance by long odds of getting in first.

* * *

SOMETHING ABOUT SYSTEM.

W. L. CHENEY.

The editor has requested me to write something about "system" in the shop; I would rather be excused, because if a person is not born systematic, it is not possible, in my opinion, for him to achieve system, or have system thrust upon him. In a general way, my idea of system is this: Doing things some good way, and (now comes the point) *knowing positively whether a thing has been done or not.*

The trouble with some people is that they sneer at all system as *red tape.* Such people do not know the difference between the two and probably could'nt learn.

In fact there is a vast difference, and here in my opinion is the difference: If I had charge of certain details of manufacturing and should say that nothing whatever should be done in the factory without a written order, this might be either system or red-tape according to the way it should be carried out.. If I should say that nothing should be done in the factory without a written order *signed by me*, this would be red tape; because if I were for any reason absent from the factory, needed work would probably be delayed, and the routine be broken up, which would be expensive. If, however, I should authorize certain other persons to write necessary orders in my absence and should then say that no work should be done in the factory without a written order signed by some authorized persons (who could be specified) this would be system, *provided that I could tell as soon as I got back to business*, AND WITHOUT ASKING ANY QUESTIONS, *just what orders had been written in my absence.*

I do not think any set rules can be made for shop systems; the detail of system that would be all right for a sewing machine shop would probably be worse than nothing in a gum drop factory.

Another reason why some people sneer at system, is because they expect the system to be automatic; or in other words, that the system having been once established, will run itself while they go a fishing.

For instance, part of a system that I am at present using, consists of a list of steel castings that is supposed to be gone through once a month, because it takes so long to get the castings that they must be kept in stock, as waiting until they were actually needed before ordering would be too late. It is easy enough to print the lists, but I do not know of any way to make the lists take care of themselves; *the stock must be looked over by some intelligent human being*, and this same being(or some other) *must remember to do it* at the specified times. Of course any good way of jogging the memory in such matters, would be a proper detail of the system.

Again, in this example, if I get out a new pattern, and *fail to add it to all my printed lists*, the "system" is worse than nothing because, *with the list*, no one tries to remember what is wanted, as the list is supposed to be right: therefore anything not on the list is sure *not* to be ordered.

I might go on giving examples, but they would show nothing more than what was first stated. That system consists in doing things in some good way, and knowing positively whether a thing has been done or not; but as before hinted, the most important thing is to follow the system up, and see that it is used and not abused.

System is good: Red Tape is evil and will do more harm in a week, than system can overcome in a year.

IRON AND STEEL.

GRANT HOOD.

I know of no subject that would interest the many readers of this paper more than iron and steel and their treatment.

The proper treatment of steel is of vital importance today not only to the machinist, but to the electrician, the engineer, the watchmaker and to nearly every person who has a chosen trade or profession.

It is not the intention of the writer to discuss the good and bad qualities of steel made by the different firms, nor to instruct those persons who are already thoroughly competent and understand all about it, but this article is to instruct the beginners, those fairly well informed, and perhaps a few things may be said which will interest the best informed; if so the writer will be satisfied.

Iron is an elementary body and is the most common and useful of the metals used to a certain extent in nearly every trade or art; when converted into steel it is used in nearly all tools. Did you ever think what the machinist would do without it?

We have and use iron in three forms, viz.:

1. Cast iron.
2. Wrought iron.
3. Steel.

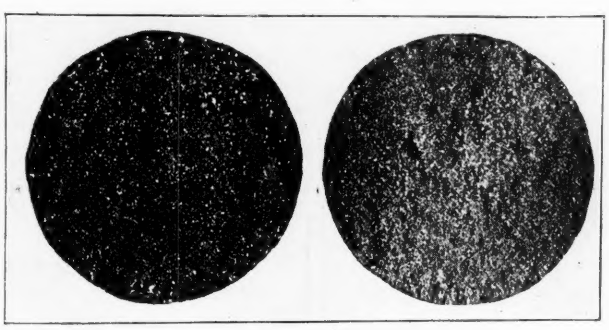
It is surprising how many of our best workmen there are who know but little of the real difference between these three forms.

Cast iron is of course the cheapest and most common, and contains from 2 to 5 per cent. of carbon. Wrought or malleable iron contains the least carbon, its amount being from $\frac{2}{10}$ to $\frac{5}{10}$ per cent.; therefore it can be made from cast iron by removing some of its carbon. The third form, steel, is what we wish to understand thoroughly. It contains less carbon than cast iron and more than wrought iron, its amount varying from $\frac{5}{10}$ to 1.5 per cent. We can convert iron into steel by *case hardening*, which is only a method of adding carbon to the iron.

We have three forms of steel, viz.:

a. Natural steel.
b. Shear steel.
c. Cast steel.

a.—Natural steel is made from wrought iron by heating for several hours with charcoal, which increases the amount of carbon, therefore converting it to steel; but steel made in this manner is far inferior to either shear or cast steel.



FIGS. 1 AND 2

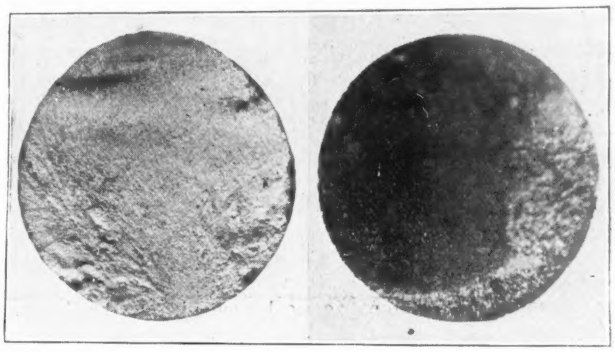
b.—Shear steel is made by binding several bars of steel together in a bundle and forging at a red heat, after which the same process is repeated; this often shows streaks where it has been welded, after being ground and polished; therefore it is not suitable for the best work.

c.—Cast steel is used to-day in making all the finest tools, and wherever a superior grade is needed. I will not attempt to discuss the various grades of cast steel manufactured, but hope to bring out some useful points on working any and all grades of the metal.

Cast steel is the only kind that can be evenly polished or turned perfectly round after hardening and tempering. The most important point for us to consider is the very best method of hardening and tempering. We must first make a careful study of the piece we have to use, and when familiar with a certain grade, it is well to continue using the same, for another grade treated in a like manner may give nothing but the poorest results.

In hardening *all articles* make it *a rule* to harden it at as *low a temperature* as possible. This I will prove by the aid of a microscope and camera. These are careful experiments performed by the writer himself. We take a piece of the highest grade of steel it is possible to procure, .20 inch in diameter, and harden first by heating to a white heat, then placing it in a vise we find it breaks easily, almost without an effort. Fig. 1 shows the grain highly magnified; it is coarse crystallized and its strength is gone, to use a common word it is "burnt." Now we take the same rod of steel and harden at a bright red heat, and taking to the vise again find it not so easily broken, but upon breaking it we find the grain as shown in Fig. 2—not so coarse and most of the crystals have disappeared.

Next we take the same rod and again harden at the *lowest temperature* possible, put again in the vise, and what a change has taken place! Now we must take a hammer to break it, and when broken the piece is found on the opposite side of the room. What a decided difference in the grain, we see it in Fig. 3; it is very fine, the crystals have entirely disappeared and we have a piece of steel hardened as well as it possible to do so. We learn from this that in the same proportion as we over-heat in hardening, in the same proportion do we decrease the strength of the article hardened.



FIGS. 3* AND 4.

There are many methods and "patent compounds" for hardening; in my own experience water, oil and mercury are the most useful. Very small articles may be hardened in the air, the moisture (or water) in the air acting just the same as though it were in a barrel or basket. Few readers of this paper perhaps have occasion to harden articles so small. An article hardened in mercury, nitric acid or cyanide of potassium will be very hard and brittle. When hardened in oil, beeswax, etc., it will be hard and quite tough. A polished piece of steel may be hardened without destroying the polish if we can do it without its coming in contact with the air; the oxygen of the air is what makes the metal black by forming an oxide; therefore if we place our polished articles in an iron box filled with animal charcoal, then by heating to a low cherry red and plunging all into water or oil, our articles will be nicely hardened and still polished. To prevent a piece from springing, it should be heated the same throughout and plunged into the water lengthwise, and as I was once instructed, "Be sure you take it out of the water straight."

Hardening a piece increases its dimensions; an interesting experiment will prove this. A piece of *drawn* steel wire .92375 inch long was hardened, after which it measured .92695 inch in length, an increase of .0032 inch; then the same piece was annealed, when its length was .92325 inch, or .0005 less than before hardening, which is accountable by the steel being rolled or drawn, which gave it a small amount of hardness.

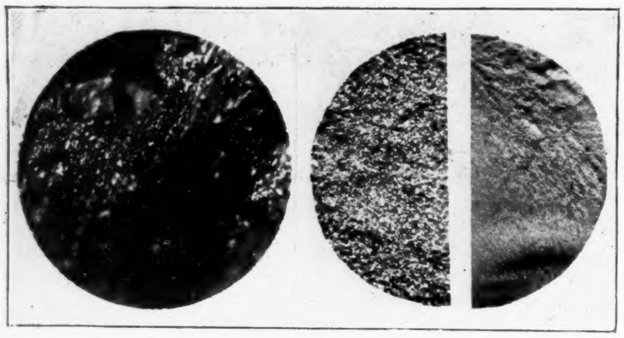
A piece unevenly heated in hardening will always spring, as

* Original piece .20 in diameter.

the hottest part will expand more and will be set in that form after cooling.

TEMPERING.

This term is often misused, as many speak of tempering when they mean hardening. After hardening there is a great strain among the particles or molecules of the steel, which is relieved by tempering. As we increase the temperature in tempering we decrease the hardness of the metal. A polished surface of steel when heated first becomes a light straw and then dark straw, purple, blue, etc., which is caused by the oxide formed on its surface. If we could temper a piece without its coming in contact with the air then its polished surface would not be changed; this we can do by using oil. If we place our articles of polished steel in a vessel of lard oil or beeswax and heat until smoke arises from the surface of the oil we will have the same temper as though it had been drawn to a "straw," then heating until we have a dense smoke we have a dark straw; when heated until the surface of the oil ignites we have a dark blue or purple, and when the oil burns steadily we have a blue or spring temper, and during this



FIGS. 5 AND 6.

time the surface of the steel has not changed at all A piece of steel may be drawn to the same color several times without its becoming any softer, as each succeeding time the same color is reached at a little lower temperature.

ANNEALING.

The ordinary steel of commerce is often found too hard to work easily for some purposes, and again we wish to use pieces that have been previously hardened in our work; therefore it is necessary to know how to soften or anneal such pieces. Doubtless all of my readers have noticed at times while hardening a piece of steel when the heat was too low, that instead of the article being hardened it was softer than at first; we take advantage of this in "water-annealing," which is done by heating an article just below the point at which it would harden, and plunging into water. Another method is to heat to a "cherry red" and bury in ashes *without allowing it to come in contact with the air.*

CASE HARDENING.

Often it is necessary to convert a piece of iron or certain parts of it into steel, leaving the center still soft; this we can easily do by case-hardening. There are several methods of doing this, but the best and quickest way for small artices in my experience is to heat to a red, then sprinkle powdered yellow prussiate of potash upon the metal, then heat well and slowly until of the proper temperature to harden, when it should be plunged into water. It will be found to be as hard as steel; in fact the surface *is* steel, as the carbon in the potash has united with surface of the iron, converting it into steel. Fig. 4 shows us greatly magnified the end of a small wire nail which has been case hardened in this manner. You can easily notice the difference between the steel and iron.

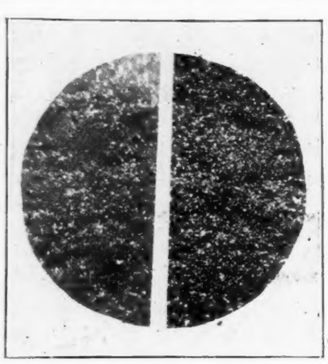


FIG. 7.

Another method is to fill an iron box with the articles to be case-hardened, and animal matter, such as horns, hoofs, leather, etc., then keeping at a red heat for several hours, which produces the same effect, only deeper.

Fig. 5 shows the grain of wrought iron highly magnified; we can see the grain almost the same as in a piece of wood. Fig. 6 shows the contrast between a piece of steel properly hardened and the same piece over-heated or "burnt." Fig. 7 shows the similarity of a piece of "burnt" steel and a piece of cast iron, both having a very coarse, crystallized grain.

Hoping the benefit of my experience in this line may prove of interest to many of the readers of your paper, who perhaps are just ascending the ladder of fame, and wishing them abundant success in their efforts, I will bring this to a close.

* * *

PROPORTIONS OF GEAR-WHEELS.

H. HEYRODT.

By assuming the entire load to be borne by the point of one tooth, the most disadvantageous condition is considered, and dimensions sufficient to meet these conditions will be ample under any circumstances. Referring to Fig. 1, we consider the tooth as a beam fixed on one end and loaded on the other.

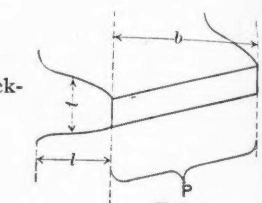


FIG. 1

Notation:

P = total load on tooth.

t = (h in original formula) = thickness of tooth ½ pitch.

l = length of tooth = .7 pitch.

b = face of tooth = 2½ pitch.

T = safe working load.

Weisbach's formula for beams:

$$P = \frac{b\,h^2}{l} \times \frac{T}{6} \quad (1)$$

The assumed constant width of face (2.5 p) makes it possible to state all dimensions in terms of the thickness.

$l = 0.7$ pitch $= 1.4\,t$.

$b = 2.5$ pitch. $= 5\,t$.

Taking the average tensile strength of cast iron as 18 500 pounds per square inch, a factor of safety of 8 gives:

$$T = \frac{18\,500}{8} = 2312 \text{ pounds per square inch.}$$

Substituting these values in (1) we have:

$$P = \frac{5\,t \times t^2}{1.4\,t} \times \frac{2312}{6} \quad (2)$$

$$= \frac{11\,560\,t^3}{8.4\,t} = 1373t^2 \quad (3)$$

showing that with a constant width of face the working load varies as the square of the pitch.

As the circumferential pitch $p = 2t$, neglecting backlash, we have:

$$P = 1373t^2 = 344\,p^2 \quad (4)$$

and calling the lineal velocity at the pitch line in feet per minute v, we have:

$$H.P = \frac{Pv}{33\,000} = \frac{344\,p^2 v}{33\,000} = 0.0104\,p^2\,v \quad (5)$$

Or we find the HP: Square the pitch in inches and multiply by the velocity in feet at the pitch and point off two decimals.

Examples: A gear-wheel 24 inches diameter, 1¼ inch pitch, 80 rev. gives 502 feet per minute.

$$502 \times 1.25^2 = 502 \times 1.725 = 7.89 \text{ HP.}$$

Mr. Klindworth's wheel:

$$1570 \times 5.752^2 = 1570 \times 33 = 5.19 \text{ HP.}$$

Mr. S. Webber's wheel:

$$1579 \times 4^2 = 1570 \times 16 = 2.51 \text{ HP.}$$

The proportions of rim given by Prof. Reuleaux are satisfactory as any. Calling the pitch p, thickness of rim on edge d, we have the empirical rule:

$$d = 0.4\,p + 0.12 \text{ inches } (6),$$

To permit easy moulding, the rim is beveled toward the centre, thickness at centre line $= \frac{6}{5}\,d$.

The web, which runs around the inside of the rim, is made equal to d.

For gears of moderate size, 12 to 36 inches diameter, the arms are generally made of elliptical cross section, the minor axis being one-half the major axis. To save much computation, the following table, giving the values of the minor axis, will be found

useful. The values give the sizes of the arm at the rim of the wheel, and a taper should be given towards the hub. Prof. Unwin recommends $\frac{1}{32}$ for small wheels and $\frac{1}{48}$ for large ones.

The dimensions of the hub may be based upon the diameter of the shaft, and using Releaux's formula, we have:

v= diameter of shaft.

s = thickness of metal around hole.

$s=\frac{1}{3}r+0.2$ inches. (7)

TABLE OF VALUES OF MINOR AXIS.
Diameter of Gear in inches.

Pitch in inches.	12	14	16	18	20	22	24	26	28	30	32	34
½ inch....	0.41	0.44	.46	.48	.49	.50	.52	....	....	1.04	....	....
¾ inch....	.50	.57	.60	.62	.64	.66	.68	.70	.72	.74	....	....
1 inch....	.66	.69	.72	.75	.78	.80	.83	.85	.87	.89	.92	.94
1¼ inches.	....	.80	.82	.97	.90	.93	.97	.99	1.01	1.04	1.06	1.08
1½ inches.	....	....	....	.98	1.02	1.06	1.09	1.12	1.14	1.17	1.20	1.22
1¾ inches.	....	....	....	....	....	....	1.20	1.24	1.27	1.30	1.32	1.35
2 inches.	....	....	....	....	....	....	....	1.35	1.38	1.42	1.45	1.48

* * *

ENGINE REPAIRS.

There are some engineers who will let the plant over which they have charge stand idle for a long time, in case of an accident, waiting for the repairs to be made by the builder of the engine, or by the nearest machine shop; others seem to be able

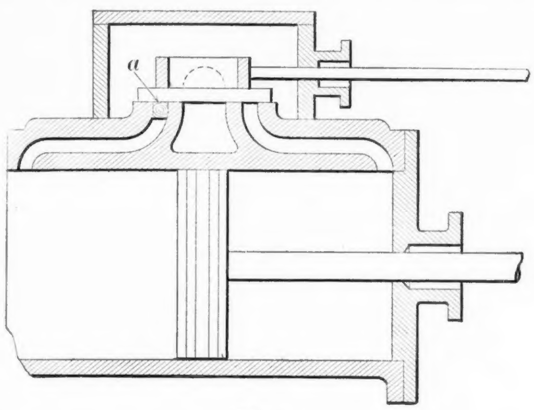


FIG. 1.

to cobble up something at once by which the engine may be kept running until permanent repairs are effected. It is largely this latter feature that makes one man worth from $5.00 to $20.00 a week more than another.

We will suppose that through some one's carelessness or from other causes a cylinder-head is blown out—say the "out" end, or that furthest from the crank. Some men would lay up the engine for a few weeks until a new head could be got in place. Others would have the engine running in a few hours, by blocking the port at the injured end, with a piece of wood cut to fit; the action of the steam swelling it and making it steam tight even against the pressure in the chest (see *a*, Fig. 1). In this condition the engine can be run with higher pressure and the steam cut off as before, or the valve may have some of its lap lessened so that cut-off may take place later in the stroke; or the engine may be run with half load. Of these three, the first is usually preferable, if the boiler, piping and engine are intended to stand the increased pressure; because later cut-off means increased steam

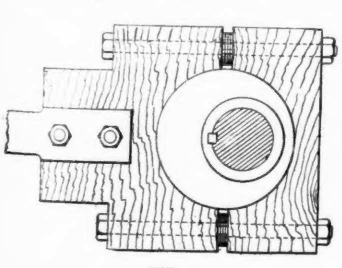


FIG. 2.

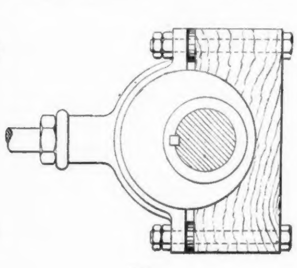


FIG. 3.

consumption per horse power. When the engine already cuts off at about three-quarter to seven-eighth stroke, as is the case in some slide-valve engines, it would be out of the question to follow later. If the valve is chipped off or planed off to cause later cut-off, strips should be ordered at once, of the desired thickness, to replace the lap when the new head is put on.

In the case of a Corliss engine, the engine may be run with one end by disconnecting the valves on that end.

In the case of a broken eccentric-strap, one may be turned up, or even sawed out, of hard-wood plank, as shown in Fig. 2. In this the halves of the strap may be sawed out of the plank by an ordinary compass saw; auger-holes are made for the bolts, and the two parts are clamped together about the sheave. The rear one (on a stationary engine) is bolted to the regular connecting-rod with the bolts used to fasten the regular strap. A circumferential groove should be made in the halves of the extemporized strap, to permit of lubrication: and the usual oil-cup may be supplanted by a grease-cup containing a mixture of lard and graphite, with which compound the sheave and the strap-groove should be well lubricated before putting the parts together.

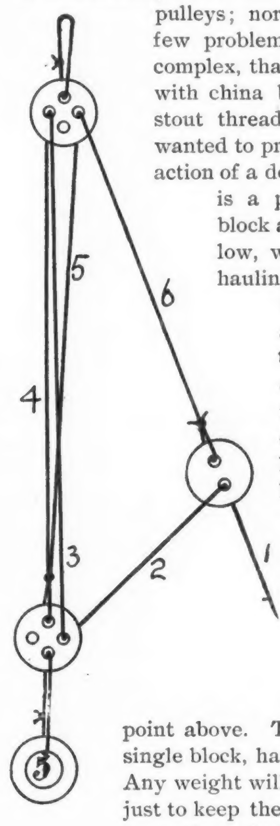
If only the front half or part of the strap is broken, the repair will be much more easy; as in this case the rear half of the strap does not need to be disconnected. The combination of iron and wood is shown in Fig. 3.

* * *

WORKING OUT TACKLE PROBLEMS.

Sometimes a dispute or a doubt arises about the multiplying power of a tackle, and where there are two or more sheaves to each block, or two or more sets of tackles working in combination, as in the double Spanish burton, or a "luff on luff" tackle, it is well to have some method of showing with absolute certainty what the maxium of theoretical lifting power of the combination is.

It is not always convenient to rig up a small model with real pulleys; nor is this necessary. There are very few problems in tackle, however compound or complex, that may not be solved in a few minutes with china buttons and ordinary string or even stout thread. For instances the other day I wanted to prove beyond all question what was the action of a double Spanish Burton, which to many is a paradox, as there is a fixed double block above, and a movable single block below, with a second movable single block hauling apparently on both the single and the double block. Three buttons and a few yards of druggists twine proved the matter beyond all question, so quickly, and so conveniently, that I thought it worth while to jot the thing down for the benefit of others who have wanted to solve a similar problem but have not thought of so simple a way. The sketch shows two four-hole buttons and one with but two holes, although this last could have had four holes without affecting the result. The upper one represents the double block, and is attached by a twine loop to some fixed point above. The lower, representing the movable single block, has the weight attached to it by a loop. Any weight will do; a key or anything that is round, just to keep the kinks out of the cord. The length of cord marked 5, 6, is made fast to the tops of both of the lower pulleys. Another length may be carried from the top of the lower button, up through one of the holes in the upper one, down through, another in the lower one, and through one of those in the small-sized button, so that we have what is practically a second rope, 1, 2, 3, 4, although in this case there was but one continuous cord "seized" so that the parts 5 and 6 worked independently of 1, 2, 3, 4. Arranging the cord so that there was a distance of just one foot between the edges of the upper and the lower button, and then hauling on 1 until the buttons touched (or was "chock-a-block" as the sailors say) it was found necessary to haul out just five feet of 1. This proved that the power must move five times as fast and far as the weight to be lifted; and this being so, one pound of power would raise five pounds, if it were not for friction. The maximum theoretical power of the system was thus very easily proved to be five-fold. The button with four holes will answer as well as the representative of a three-sheave pulley, and with a few of them there is no combination that may not be made and no problem relating to ordinary grooved sheaves that may not be worked out.



SOME FOREIGN IDEAS.

ENGINE DETAILS—"GEE" TEETH.

While these details may not be new in every sense of the word, it is certain that most of them are different from our usual every-day practice and will, we think, be interesting to those who like to know what is being done abroad as well as at home. The engine details are taken from the catalog of H. Bollinckx, Brussels, Belgium, and show details of several parts of their engines.

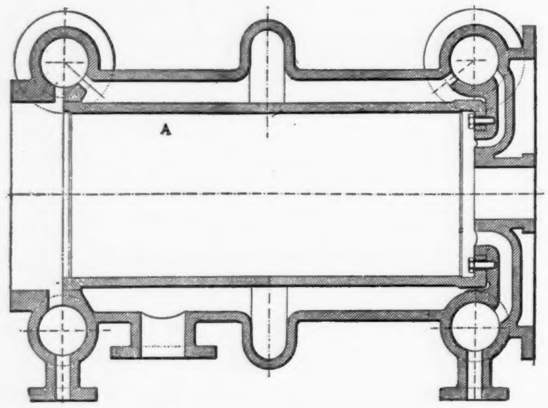


FIG. 1.—JACKETED CYLINDER.

Fig. 1 shows a section of a jacketed Corliss cylinder as made by them. The internal shell or cylinder, A, proper, is a separate casting fitted into the outer shell or jacket, as shown; the jacket having an expansion chamber cast in the center as shown. It will also be noticed that the steam ports are hereby necessarily placed in the head, making longer steam ports and a little more clearance on the end. The excellent results of these engines, however, show that this does not materially affect the economy.

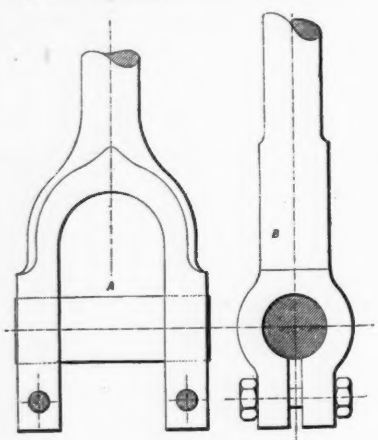


FIG. 2.—ROD CONNECTIONS.

In Fig. 2 we have some of the rod connections used for cross-head, the left connection, two views, showing a plain pin clamped between the forked ends of connecting rod, the other showing wrist pin held in solid rod ends by a pin through one side; in this there is a plain bushing, probably bronze, which can be forced out and renewed when worn.

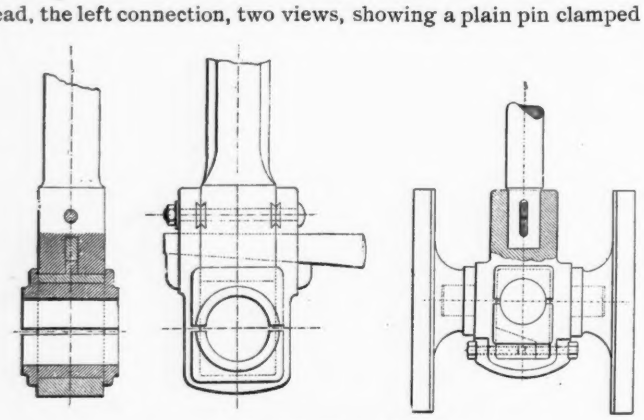


FIG. 3.—CONNECTING ROD AND CROSSHEAD.

The crank pin end of connecting rod is shown in Fig. 3 which, while neither new or startling, is not common here although it is a solid construction. The double dovetail keys which look something like the moulders chaplet, aid in keeping the strap from moving. The crosshead is different from anything in common use here and consists of the two shoes or sides and the body or central piece, which fits into the shoes by the pins or trunnions shown. The piston rod is keyed into this body which contains the boxes, strap and wedge for tightening, as can be seen on close inspection. These fit the pin shown in the forked end of connecting rod in Fig. 2, so that bearing is in the crosshead. This adjustment of the shoes allows for any ordinary variation from truth that might be found in the crosshead guides of the engine frame.

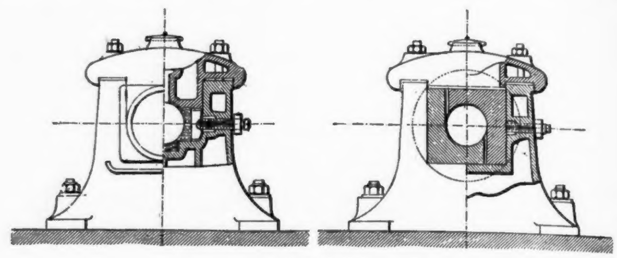


FIG. 4.—PILLOW-BLOCK ADJUSTMENT.

The pillow-block adjustments in Fig. 4 show the different methods employed for this important bearing. The method shown at the right is not often found in our practice, although the one on the left is not uncommon.

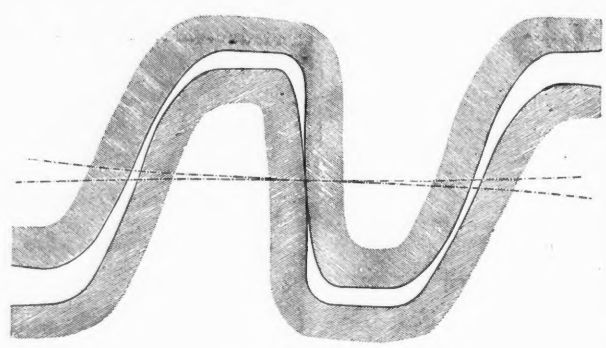


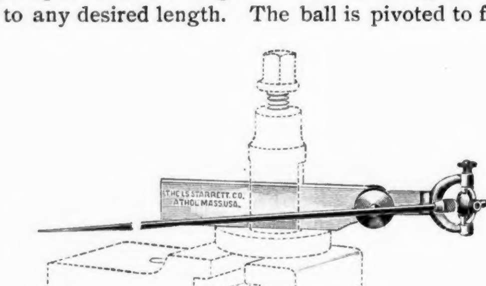
FIG. 5.—"GEE" TEETH.

The form of gear teeth shown are called "gee" teeth by their originators, P. R. Jackson & Co., Salford Rolling Mill, Manchester, England. They are of course only suitable where the power is transmitted in one direction only. The working side is made in the usual form, but the back or non-driving side is strengthened so as to increase the strength of the tooth about 35 per cent. over the ordinary. These are supplied without extra charge.

* * *

STARRETT'S CENTER TESTER.

Nearly every mechanic needs an instrument of this kind to use in adjusting and centering any point or hole in a piece of work in a lathe chuck or on a face-plate; also to test the truth of lathe centers or a shaft between the centers, the instrument being held in the tool post. The indicating needle passes through the ball, having a split stem, forming a chuck for holding the needle adjusted to any desired length. The ball is pivoted to form a universal joint, but may be instantly converted into a single joint for a tilting motion by tightening the knurled nut, adapting it for both inside and outside surface contact. A steel bead, not shown in the cut, and carried on the needle, slips over the point of same when used for inside work. The instrument is joined to a tool-post shank by a flexible steel ribbon with sufficient spring to properly hold the needle in contact with the work. It is made by the L. S. Starrett Co., Athol, Mass.



MACHINE SHOP ARITHMETIC.

A series of practical articles clearly explaining the portions of mathematics which will be useful to the men in the shop and engine room.

PRACTICAL QUESTIONS CONNECTED WITH THIS SUBJECT WILL RECEIVE PROMPT ATTENTION.

SPEED OF SHAFTS AND PULLEYS—PROPORTION.

Caleb Topham.

One of the greatest helps in making any machine shop calculation is a liberal supply of common sense, which unfortunately doesn't seem to be as liberally supplied by Nature as we might wish.

It is absolutely essential to the expert mathematician, and the more one has the better he can calculate and the less trouble it is to him. He must have a fairly clear head and be able to reason out the different steps one at a time as he reaches them, and not go jumping all over the lot after something that he doesn't need at present; each step must be made as we come to it, then the hard spots disappear. The man at the lathe or bench may think he can't do this, and perhaps he can't; some of the best mechanics I know of can hardly figure the speed of shafting, yet they acknowledge they would be better off if they could, and if any of them read this I shall expect a medal, *i. e.*, if they understand it.

One of the most common shop calculations is that of finding the speed at which a shaft is running, or of finding the right size pulley that will give the required speed to the machine, and this will serve to show the use of the cold-blooded reasoning as well as anything. Our line shaft runs 200 turns per minute, and our emery wheel should run 2 000 turns per minute. The pulley on the grinder is 4 inches in diameter and belts direct to the main shaft; what size pulley should be used to drive it?

The rule says: "The diameter of the driving pulley is to the diameter of the driven as the revolutions of the driven are to the driver." Clear as mud to the average mechanic; the "is to" generally floors him. This can be cleared a little by saying that "the diameter of the driving pulley multiplied by its revolutions per minute equals the diameter of the driven pulley multiplied by its revolutions per minute," and this will be found easy after a trial. By our problem we know the diameter of the driven pulley to be 4 inches, and its revolutions 2 000 per minute, and 4 times 2 000 equals 8 000. Then as the line shaft runs 200 turns per minute a little reasoning shows that according to our last rule 4 times 2 000=8 000, which equals 200 multiplied by some number which will make it 8 000 also. It is clear then that 8 000 divided by 200 will give the required number and 8 000 divided by 200 equals 40, the diameter of pulley required to drive the emery wheel at the desired speed.

A little more reasoning shows that as 2 000 is 10 times 200, or that the speed is multiplied by 10, and also that the diameter of the driven pulley multiplied by 10 gives the diameter of the driver, from which it will be seen that the speed varies directly with the relative diameter of the pulleys. In other words the larger the driving pulley the greater the speed of the driven (the revolutions of the driving shaft or the pulley remaining the same) and consequently the smaller the diameter of the driving pulley the less the speed of the driven. Now considering the driving pulley of fixed diameter we see that the smaller the driven pulley the greater its speed and the reverse (conversely, the text books say), or that the greater its diameter the less its speed.

Then if we have two pulleys of the same size it is evident that both will revolve the same number of turns per minute. Considering our line shaft as before, at 200 turns per minute and 24-inch pulley on it as the driver, how fast will a countershaft run whose pulley is 12 inches in diameter? You can follow the rules if you choose, but why not do a little thinking, just to exercise your thinkery. The driven pulley is the smaller, then of course it will run faster. How much faster? As it is half as large it will run twice as fast as 2 times 200 equals 400 as the revolutions per minute of the 12-inch pulley. Now we have been doing a little proportion, "rule of three," our daddies called it, and we didn't know it. We said to ourselves, 12 inches is half 24 inches; then the small pulley will run twice as fast as the large one. Or stating it in proportion we say 12 : 24 :: 200 : 400, or as 12 is to 24 so is 200 to 400. Here it will be seen that the product of the inside figures (or second and third terms) 24 times 200 equals 4 800, and that the outside figures, 12 and 400 (or first and fourth terms), 12 times 400 also equals 4 800, showing that "the product of the means (inside terms) equals the product of the extremes (outside terms)" as the books say.

Then if we have three of these terms we can find the fourth very easily, for if we have the first, second and third, we multiply the second and third and divide by the first; in fact any way so that we multiply by the extremes and divide by the means, or the opposite. Of course when we have a simple problem as before, where the pulleys or revolutions are even numbers, we can readily divide and multiply in our heads without using paper and pencil at all, but all problems are not so simple. A line shaft runs 180 turns per minute, the driving pulley is 22 inches in diameter and the countershaft pulley 8 inches in diameter, how fast will the counter run? As the driving pulley is larger than the driven, we know the counter will run faster than the line shaft, so we make the smaller number our first term and say: As 8 is to 22 so is 180 to the answer, in this case the speed of the counter. Multiplying the means we have 180 times 22 equal 3 960, divided by 8 equals 495 revolutions for the countershaft.

We could have obtained this same result by first finding how many times 8 was contained in 22, or $2\frac{3}{4}$ times, and then multiplied 180 by the $2\frac{3}{4}$, but the first way is generally preferable.

In making your proportions (stating them, it is called) you will note that the first and second terms are similar quantities, such as diameters of pulleys, revolutions of shafts, etc., and that the third and fourth terms are also similar, so that the third term must always be the same kind of thing as the desired answer.

Taking another case we have a grindstone which must run 100 revolutions per minute; the line shaft runs 180; if the grindstone pulley is 12 inches in diameter, what must the pulley on line shaft be? A little more reason shows us that as the grindstone is to run slower than the line shaft, the driven pulley must be larger than the driver, and as the desired answer is the size of the pulley, the grindstone pulley must be third term. Now taking the size given we say that, as the answer must be smaller than the third term, we divide by the larger number and say 180 : 100 :: 12 : answer. $100 \times 12 = 1\,200$ and 1 200 divided by $180 = 6.66+$, then size of driving pulley must be 6.66 inches.

Line shaft makes 175 turns, pulley on counter is 9 inches in diameter, counter must run as near 250 turns as practical, what size pulley must go on line shaft? Answer is size of pulley, then size of counter pulley is third term. Machine must run faster than line shaft, then driver must be larger than driven, so first term must be smaller than second, or in other words the divisor must be smaller than multiplier (first term is divisor, second is multiplier). So we say: As 175 : 250 :: 9 : answer. $250 \times 9 = 2\,250$, divided by $175 = 12.85+$, or about $12\frac{7}{8}$, probably a 13-inch pulley would be used unless it was a special case.

So far we have dealt with direct proportion; inverse or indirect is a little more puzzling, but was made very clear by Mr. W. L. Cheney, in the January issue; a little reasoning will help wonderfully, however, as in all other problems. Proportion is not, however, confined to pulleys or belt speeds, but comes in very handy in nearly all calculations; thus if an iron shaft 15 inches long weighed $2\frac{1}{2}$ pounds, how much would a piece of the same shaft 9 feet 3 inches long weigh? Reducing the lengths to inches so as to have similar measurements we have 9 times 12 equals $108+3.=111$ inches. Then as 111 inches weigh more than 15 inches we say: As 15 : 111 :: $2\frac{1}{2}$: $18\frac{1}{2}$ pounds.

Here are a few examples for practice:

1. If the engine runs 120 turns per minute and has an 8 foot fly-wheel, what size pulley must be on the shaft to run it at 200 turns per minute?

2. A line shaft runs at 200 revolutions per minute, the counter pulleys are 12 inches in diameter, the lathe cone has two steps 4 and 8 inches in diameter, with counter cone the same size; what size pulley will be needed on line shaft to drive the lathe 800 turns per minute when belt is on smallest lathe cone?

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

54. A. R. T. asks for information concerning the speed of milling cutters *A.* The usual practice to-day ranges about as follows:

Steel.	Wrought Iron.	Cast Iron.	Brass.
36	48	60	120

the figures giving the speed of the teeth of milling cutter in feet per minute. A close approximation of the revolutions required to make the desired speed can be had by multiplying the speed in feet per minute by 4 and dividing by the diameter of the milling cutter. As, supposing the cutter is 3 inches in diameter and you wish to mill wrought iron with it, you multiply 48 by 4 and divide by 3, giving 64 revolutions per minute as the desired speed. Far higher speeds than these have been obtained and some are reported as high as 200 feet per minute for cast iron.

55. B. A. J. sends a sketch of a bicycle driving device, which has a peculiar lever connection to the crank. He asks us what he shall do with it, as he says he can gain 20 per cent. of power. *A.* This is another case of attempting to "gain power" or obtain something for nothing and, as with most of them, it is attempted to do this by the use of levers. You cannot arrange levers or anything else so as to give back more work than you put into them; all that you can do is to use the power with the least loss. The articles on "First Principles of Mechanics," by Lester G. French, were written for just such cases as yours, and we advise you to study them carefully; they may save you money. If you could gain 20 per cent. of power by adding two levers, why not add 10 levers and gain 100 per cent., or, in other words, have the machine run itself. While it may be possible to arrange a driving motion to utilize more power than is done with the crank ordinarily used, it will not be gaining any power. Our advice as to the device you send is to sell it for scrap if you can if not; throw it in some mill pond with a stone tied to it which is heavy enough to prevent the 20 per cent. of power you think you have gained from bringing it to the surface.

56. W. M. F. asks how close it is safe to order forgings to the required size and allow a finishing cut? *A.* This will depend largely on the article in hand and the accuracy of the forging. If it is plain work with no parts which are difficult to forge an allowage of from 1/16 to 1/8 of an inch on each finished side will be ample. For tool steel, that is to be hardened, it is not considered good practice to remove *less* than 1/16 of an inch from the surface before hardening, as the hardening is not apt to be satisfactory if this is not observed.

* * *

A young draftsman who recently took hold of the circulation work on MACHINERY writes:

I started on my wheel last week and have visited five small towns near here where there are shops and mills employing machinists. In nearly every case I found that MACHINERY was favorably known, and in every case I was well treated. I have done much better financially than I expected to the first week, and have also got quite a number of pointers for an article I will send you soon, to say nothing of ideas that will help me immensely when I go back to regular work. The pleasure of a free and easy life like this after being cooped up in the drafting room all winter is not easily described. It's great!

If you are interested, see the advertisement on last page of reading matter, or address MACHINERY, 411-413 Pearl Street, New York City.

* * *

MR. E. P. ROBERTS, Consulting Engineer and President of The Correspondence School of Technology, Cleveland, Ohio, has been appointed Consulting Engineer for the Port Clinton, Ohio, Electric Light and Power Company.

A PECULIAR BREAKDOWN.

Some weeks ago the occupants of the Scott & Bowne 12 story building (called Cod Liver Oil Building, by some of the unregenerate), MACHINERY among the others, were informed of the breakdown of passenger elevator number two, and elevator number one was kept on the jump to take care of the traffic and do double duty. Our pleasure on learning one morning that elevator number one was also out of commission can readily be imagined but not described, as the whole traffic of the building was then confined to the freight elevator. The engineer, Mr. Boyd, informed us that the break was a peculiar one and showed some of its features.

Fig. 1 shows the end of the hub on the hoisting drum where the break occurred. The sudden reversals due to elevator service are hard on any metal, and from the evidence afforded by the broken piece, the rupture had been going on for a long time.

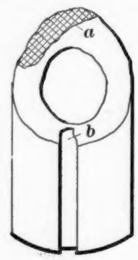


Fig. 1

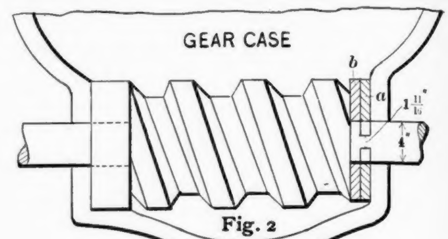


Fig. 2

The key way was cracked at both corners, and the cracks met at *b*, leaving a loose piece of metal here. The crack had extended both ways and had been gradually growing until only the portion marked *a*, and shown by cross hatching, held the drum to the hub. This was the only portion which was freshly broken, the rest being oil soaked, denoting an old crack. When the break occurred the end acted as a wedge and forced the worm wheel outward, and of course the gear case parted company with its friends.

This laid the worm bare as shown in Fig. 2, and new discoveries were made. The thrust of the worm was all toward the left end as shown by arrow, as the car was not quite counter-balanced and kept the worm against the "take up" at the left, not shown in cut. This left the rings *a* and *b*, of steel and brass respectively, to revolve idly on the shaft, and thereby hangs a tale, as the story goes. The brass ring, *b*, had been worn away by the shaft so that its inside diameter was much larger than when new while the reverse had taken place with the steel ring, which had worn its way into the shaft until its original diameter of 4 inches had been worn down to 1 1/16 inches, and was still doing its work, although its cross sectional area had been reduced from 12.56 square inches to 2 26 inches, showing that a *fairly large* factor of safety was used in designing this shaft.

The machines are the wheel and worm type of the Otis make, and as a result of this breakdown inspections are said to be under way in all their plants in New York City.

* * *

AMERICAN FOUNDRYMEN'S ASSOCIATION.

The first meeting of this new association was held at the Manufacturers' Club, in Philadelphia, Pa., on May 12th, when the organization was effected. There was a remarkably good attendance and the evening sessions at the Franklin Institute were thoroughly enjoyable. The meeting was called to order by Mr. F. Schuman, of the Tacony Iron & Metal Co., who delivered the opening address. He was followed by Mayor Warwick, of Philadelphia, with one of his witty speeches, which are at once appropriate and amusing.

The paper by Mr. A. E. Outerbridge, on "Foundry Cranes," was timely and, as with all his work, thoroughly practical and up to date. The relative advantages of different types of cranes were clearly discussed and one instance cited where a proper distribution of cranes gave double the amount of work per man obtained in a similar foundry, with poor crane equipment. A series of interesting lantern slides showed the various improvements in crane building, beginning with the old Pinchbeck, or "walking wheel," arrangement, and coming down to the latest cranes built, including the 100 ton electric crane in the erecting shop of the Baldwin Locomotive Works, and also a 150 ton crane.

Mr. Curtis W. Shields, of the Ingersoll-Sargeant Drill Co., presented a paper on "Compressed Air in the Foundry," which gave much valuable information in this line. It was said that a small

compressor suitable for any moderate foundry duty could be readily obtained, which would give an efficiency of 85 per cent., while the saving resulting from the use of compressed air in foundries is almost beyond expectations. He discussed the construction of an air compressor, showing the weak points and the remedy in most cases.

The use of belt or steam driven compressors was also discussed, the steam driven having the advantage among others of being in the engine room away from the dirt of the foundry, while the belt driven compressor is usually placed in the foundry, and has not only the dirt to contend with, but requires the use of shafting and belting. The question of laying out piping for carrying the air to the desired point, and it was recommended that the velocity shall not exceed 20 feet per second, when it can be conveyed a long distance with very little loss; the pressure necessary to force air through a pipe varying as the square of the velocity. The case of the famous Jeddo tunnel was cited, where air at 60 pounds pressure was driven 10 680 feet through $5\frac{1}{4}$ inch pipe with no loss of pressure, the velocity being low.

A receiver of good size is recommended as a reservoir, to be of as great capacity as the rating of the compressor in cubic feet of free air per minute. The application of compressed air to hoists was well tested, as well as the cheapness of compressed air for such uses. The sand blast, moulding machine, pneumatic chipping chisel and pneumatic-hydraulic elevators were also mentioned and data given regarding them.

* * *

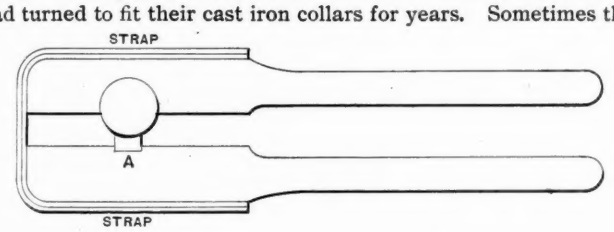
WHAT MECHANICS THINK.

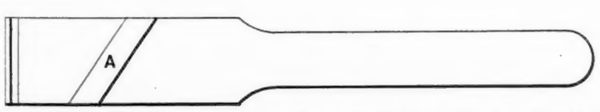
THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

FILING DOWN A SHAFT.

Mr. T. P. Pemberton's hints to draftsmen and machinists in your December issue pleased me very much, as the sketch-book is better to the every-day shopman than the text-books, which they have at home. A workman should have several different ways of doing a job with the different tools surrounding him. Every machine shop has a standard for turning shafts; some turn down the 2 inch rough shaft to $1\frac{29}{32}$ and call it 2 inches, while some take a $2\frac{1}{16}$ or $2\frac{1}{8}$ rough shaft and turn same down to 2 inches exact. A shop I once worked in had a lot of shafts which they had turned to fit their cast iron collars for years. Sometimes the



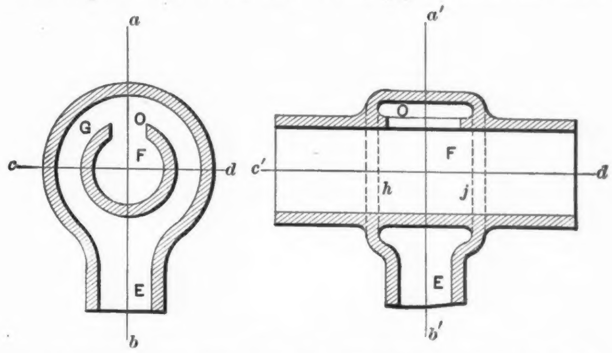


collar would not go over the shaft in all places, and we would file and try and force the collar back and forth until the collar had worn $\frac{1}{64}$ since it was new. So many complaints came about our large shafting, as it would not fit our old standard pulleys, we got up a rig like sketch. We broke up a smooth file and put same in a wooden clamp at A, and by letting the shaft run fast in the lathe we went over the shaft in a hurry and all were left as round as the tool left them, and perfectly smooth. Care must be taken not to squeeze the clamps too much and also to have the file set at an angle to center of shaft. F. E. G.

San Francisco, Cal.

MAKING THE CORE-BOX.

A core-box for the pattern shown can be made in several ways, but one way may have an advantage over another, depending on the size of the core. If the overflow passage was large enough for the moulder to get his hand in the opening E and around to point O, so as to pack the sand at this point, it could be made cheapest by parting it through the line *a' b'*, as both halves could be conveniently turned out on the lathe, except the passages E and O, which could be worked out by hand. If the width of the passage at G was but one-eighth of an inch, it would be a difficult matter to get the sand properly packed at point O. Under this condition it would be advisible to make the core-box in such a way as would be more convenient for the moulder. To accomplish this, the core-box may be parted through the line *c' d'*, and that portion of the pipe which is within the overflow, between the dotted lines *h* and *j*, should be made loose and in three segments; one taking in the semicircle below the center line *c d*, and the other two pieces the remainder of the pipe above the line *c d*.



Each of these three pieces, which would remain with the core while the core-box is being withdrawn, would have to be parted through the line *a' b'*, so that they could be drawn from the core after the core-box has been withdrawn. Still another way would be to make it as just explained, except that portion of the core-box, below the line *c' d'*, be parted through the line *a' b'*, and that portion of the pipe within the overflow, below the line *a b*, would be made fast on both sides. The advantage in this method is, that there would be but four loose pieces within the overflow instead of six; it being a disadvantage to have many loose pieces, as they are liable to be lost. E. W. KELLY.

Williamson School, Delaware Co., Pa.

The method adopted will be shown next month.—ED.

A BETTER UNDERSTANDING OF GEARS.

I note Mr. Klindworth's letter in the May issue and hasten to admit my error in not seeing that the pressure on the *face* of the supposed tooth was 840 pounds. I was figuring on a pressure of 500 pounds per square inch, or $\frac{1}{16}$ the breaking strain of 8 000 pounds as deduced from Mr. West's experiments. Now the thickness of this supposed tooth is more than an inch, that thickness would be as 500 is to 840, so is 1. to 1.68, and if we call the thickness $\frac{5}{11}$ of the pitch, the pitch would be 3.696 inches.

Now I do not alter my factor of safety for the *velocity*, for iron is just as strong at a velocity of a mile a minute as it is at 100 feet.

It is the blow which would be given by sudden resistance, at the high velocity, which requires the enlargement of the factor of safety, and here, as I have said, we are looking at the matter from different points of view: Mr. Klindworth seeing the sudden resistance from placing a bloom of iron between the rapidly revolving rollers, while my point of view was that of steady and uniform motion. It is the *condition* and not the *velocity* which alters the factor. S. WEBBER.

EVAPORATION OF WATER.

There is a simple method of ascertaining the amount of water that must be evaporated at different pressures and different conditions, which can be obtained from an indicator card, which I have never seen mentioned in such text-books as I have consulted, and may therefore be of interest to your readers.

To obtain 1 HP. per hour, 2 565 heat units must be converted into work. This is ascertained as follows:

$$\frac{33\,000 \text{ foot pounds} \times 60 \text{ minutes}}{772 \text{ foot-pounds in H. U.}} \text{ equal } 2\,565 \text{ H. U.}$$

Assume steam to enter cylinder at 95 pounds above vacuum and to exhaust at 15 pounds.

By table of properties of saturated steam per pound we find steam at 95 pounds contains 1 180.7 H. U. At 15 pounds it contains 1 146.9, or a difference of 33.8. Latent heat at 15 pounds is 965.1; at 90 pounds, 889.6. Difference, 75.5. This added to 33.8 equals 109.3 heat units. These two differences together show all the units of heat converted into power from 1 pound steam under the assumed circumstances. Therefore to have 1 HP. in the cylinder for each hour, $\frac{2565}{109.3}$ or 23.46 pounds of steam must enter the cylinder. ARTHUR PENNELL.

ONE of the most novel advertising schemes we have seen has just been issued by the Davis & Egan Machine Tool Co., Cincinnati. It is a small envelope containing a number of flax seeds with directions for using them to remove emery, chips or other small particles that are apt to become too well acquainted with the eye of the machinist. These are the best things to use for particles that are not embedded in the eye, and it was a happy thought that prompted sending out these seeds, as they will be appreciated by all who receive them, and will be kept in the tool box for use when required.

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MANUFACTURERS' NOTES.

SPENCER MILLER, engineer of the Lidgerwood Mfg. Co., New York City, has recently had a patent granted him for a novel form of scoop bucket, which has been thoroughly tested, and has proved entirely satisfactory in loam and sand. It is employed on a cableway. The bucket is lowered to the toe of the sand bank, and the carriage is run ahead so that the draw of the hoist rope is approximately parallel with the slope of the bank and the bucket is drawn up, thereby filling it. If the mate rial be soft the bucket will fill without guidance, but in harder material the bucket has to be guided by a man following it. The bucket is then conveyed back to the place of dumping, and by virtue of lowering the bucket it is overturned and the load spilled. Mr. Miller has also another patent granted him for a novel form of aerial dumping device.

IT is reported that the N. J. Car Spring and Rubber Co., of Jersey City, N. J., and the Eureka Fire Hose Company, of New York, two of the largest and oldest manufacturers of hose in the country, and whose business relations have for the past twenty years been very close, recently completed arrangements whereby the two companies will be still closer connected in the manufacture of fire, mill and other kinds of hose. All the brands of both concerns will hereafter be made and sold by each company. The line will be a most complete and extensive one, embracing as it does, hose for every purpose, each brand of acknowledged superiority in its class.

THE Penberthy Injector Co., 121 Seventh St., Detroit, Mich., write us that, owing to the marked increase in their business since January 1st, they have found it necessary to add a large number of monitor lathes and other improved machinery to their equipment as well as putting in a new engine to supply the additional power required. The stock department has been moved to another building to make room for the additional machinery.

W. F. & John Barnes Co., 231 Ruby Street, Rockford, Ill., whose metal and wood-working machinery is widely known, write us that they have recently built a 100 foot addition to their factory, four stories high, in order to supply the demands for their goods.

THE Diamond Machine Co., of Providence, R. I., report a shipment to the Japanese Government of a large order for grinding machinery received through their London house. The shipment comprises a large number of articles, including among others 10 of their large size water tool grinders.

DURING the month of April the passenger train movement on all divisions of the B. & O. system was remarkable for punctuality. The through express trains arrived at their respective destinations on schedule time ninety-five per cent. of the time. This is a performance rarely equalled by roads operating as many trains as are run on the B. & O., and speaks well for the efficiency of the rank and file, as well as the officials of the operating department. The effects of this are already apparent in increased passenger receipts.

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BUSINESS.

NO CHARGE IS MADE FOR THE INSERTION OF BONA FIDE ITEMS UNDER THE ABOVE HEAD. FOR FURTHER PARTICULARS, ADDRESS THIS OFFICE.

We have an inquiry for improved machinery for grinding or otherwise finishing the surface of rubber rolls and for grinding or finishing rubber slabs or printers' blankets. Also machinery for cutting jar rings.

* * *

FRESH FROM THE PRESS.

Practical Hints on Joint Wiping. David Williams, 232 William street, New York. 43 pages. 25 cents.

This is a reprint from "The Metal Worker" of two articles on the method of joint wiping, which is an operation requiring much skill and practice; the apprentice who learns to make a wipe joint usually considering himself a full fledged plumber. There are thirty-five illustrations, made from photographs, showing the different operations of making about all the joints commonly met with, such as round, cross, flange, Y and branch joints. This is certainly a practical little work and is sure to be in demand.

The Slide Rule; a Practical Manual. By Charles N Pickworth, Wh. Sc. Second Edition, revised. Emmott & Co., Ltd., New Bridge street, Manchester, England, and D. Van Nostrand, New York. 56 pages, 5x7 inches. Price, 80 cents.

That this little manual has reached its second edition within a year shows both the growing interest in the slide rule and the value of this book concerning it. It treats, in a concise yet clear manner, the mechanical and mathematical principles of the rule and leads up, by easily followed steps, to the various uses to which it can be put in every day use. This is followed by over twenty pages of examples in technical computation, which shows the author to be perfectly familiar with all its workings and that he has the faculty of imparting this knowledge to others as well. We can heartily recommend it to all who are looking into the slide rule, and there are few who cannot use it to advantage in their daily work, by a little study of such a book as this.

Problems in Machine Design. By Charles H. Innes, M. A. Technical Publishing Co., Ltd., Manchester, England. 187 pages, 4¾x7 inches. Price, $1.40.

This is a well written book, by an author who is well-known in English engineering circles, and contains many problems dealing with the design of machines and their solutions, which are given in a thorough manner. It is well illustrated and will, we are sure, be appreciated by its readers. There is a need for books of this kind, as the mechanic of to-day is much more of a reader than ever before, and eagerly grasps any book which will broaden his knowledge in his particular trade. The problems are practical and interesting, being taken from actual engineering practice.

Westinghouse Electric Street Car Equipment. Hutchinson & Phillips, authors and publishers, Box 268, East Pittsburgh, Pa. 91 pages, 4½x7 inches. Price, $1.

This contains a complete description of the various street car motors, controllers and other car equipments of the Westinghouse System, with full directions for inspection and repair, including rewinding armatures, etc. All directions and diagrams are made very clear and will be readily understood by any one interested, although especially valuable to street railway men. It is also of value to anyone having electrical apparatus in their charge, and should be in good demand. It is neatly bound in flexible leather and handy for the pocket.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9x12, 6x9 AND 3½x6 INCHES. THE 6x9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

ROBINSON & CARY CO., St. Paul, Minn. Catalog, No. 13. 528 pages, 6x9 inches.

Just as a library containing all the books required is much more convenient than going to all the different publishers, so is a large dealers catalog more convenient than hunting up the literature of each manufacturer—which you rarely find when you want it. This book is well-bound and contains practically all the supplies any shop is likely to need, as well as much that will supply a general trade. This firm represents many of the leading manufacturers of lathes, tools of all kinds, engines, boilers, valves, indicators and other supplies too numerous to mention. As is now customary with such catalogs, it contains several pages of useful information concerning the every day mechanical subjects, such as hydraulics, steam, boilers, threads, etc.

CASE SCHOOL OF APPLIED SCIENCE, Cleveland, Ohio. Department of Engineering, Chas. H. Benjamin, Professor of Mechanical Engineering. 16 pages, 5½x8 inches.

This gives a general outline of the course in mechanical engineering and is a very attractive little book, being interestingly written and nicely illustrated with half-tone engravings of the school buildings, which are very prettily located. Those who contemplate attending a technical school will do well to become acquainted with this one, and those who are striving to obtain an education at home can, perhaps, obtain assistance by noting the plan outlined.

D. VAN NOSTRAND CO., 23 Murray street, New York. Catalog of books. Part 2. 80 pages, 6x9 inches.

This catalog is devoted to books pertaining to electricity in its various forms, including lighting, telephony, dynamos, motors, telegraph, electro-metallurgy, etc. It is divided into sections by a careful arrangement of subjects which makes it very handy to consult, as the works on the desired subject are easily found. It will be found a convenient means of becoming familiar with the latest works on electrical subjects.

THE HOPPES MFG. CO., Springfield, Ohio. Catalog of Live Steam Feed Water Purifiers and Exhaust Steam Feed Water Heater. 56 pages, 6x9 inches.

This contains numerous illustrations of these purifiers and heaters, showing their construction and application, as well as the results obtained from their use. Excellent half-tones are given, showing various sizes of heaters, some as large as 1,800 horse power. A good list of users follows the descriptive matter, both of which will interest the engineer.

THE NILES TOOL WORKS, Hamilton, Ohio. Machine Tools. 99 pages, 4½x6 inches.

This is a very complete little catalog of their manufactures for railroad, locomotive, car, general machine shops, engine and boiler plants;

giving a brief description of the tools shown, in English, French, German and Spanish. A portion of their regular lines of tools is shown, together with special tools which they have designed for doing special work in an economical manner. The list includes lathes, planer, boring mills, wheel pressers, shapers, slotters, etc.

STOW MFG. CO., Binghamton, N. Y., catalog of flexible shafting and appliances. 40 pages, 6x9 inches.

A well printed catalog showing some of the many useful applications of flexible shafting to drilling, tapping, grinding, etc. There are many places where this shafting can be applied to advantage and those having large work, where it is cheaper to move the tools than the work in hand, will do well to become familiar with it.

THE D. E. WHITON MACHINE CO., 54 Howard street, New London, Conn., catalog of chucks. 96 pages, 6x9 inches.

This is a very complete chuck catalog and can almost be called a treatise, as it shows most of the details of modern chuck construction. The information under the head of fitting and care of chucks is valuable to any chuck user. A great variety of chucks for various uses is shown, together with principal dimensions, which makes the book well worthy a place as a work of reference. Round corners also add to its appearance and durability.

W. F. & JOHN BARNES CO., 231 Ruby Street, Rockford, Ill., catalog of metal working machinery. 46 pages, 6x9 inches.

This contains the various metal working machines made by this company, including lathes, drills, polishing machinery, screw presses, emery grinder, etc. Any machinist who has an idea of getting a small lathe for his own use, should be familiar with the Barnes. Their friction drill is well adapted for lighter work and will be appreciated; while the device used on their water emery grinder will attract any mechanic by its simplicity.

STERN & SILVERMAN, 707 Arch Street, Philadelphia, Pa., "*The Superiority of Electric Storage Traction.*"

This is a finely bound book, about 8x11 inches, and while it will probably come under the head of a catalog, is extremely interesting to those connected in any way with street railways. Although there have been numerous claims as to storage batteries being economical, they have generally failed to satisfy the stockholder, but when a house of such long standing as this one guarantees the economical performance of these batteries, the subject cannot be passed by without a careful examination. The unsightly poles and overhead wires should give way to this more desirable method, and this company should at least be given an opportunity to prove their claims.

THE RUE MFG. CO., 112 North 9th street, Philadelphia, Pa. Catalog "B" of locomotive injectors.

It is standard size and shows their well-known Little Giant, 1889 and Fixed Nozzle locomotive injectors as well as their Boiler Washer and Tester which is not as well-known as its merits deserve. With this instrument you can blow out your boiler, wash it, fill it with hot water, test it to any desired pressure and have it ready for service in one hour.

THE CINCINNATI MILLING MACHINE CO., Cincinnati, Ohio.

Milling Machine circulars describing their new milling machines which embraces many good and distinctive features. As this firm builds nothing else these machines receive their whole attention, and the result is naturally a first-class milling machine.

EVERY mechanic should send for the catalog mentioned in the advertisement of the Nicholson File Co., on page 10.